THE UNIVERSITY OF ALBERTA

A DESCRIPTIVE STUDY OF THE RANGE AND LEVEL OF MATHEMATICS COURSES OFFERED BY INSTITUTES OF TECHNOLOGY IN WESTERN CANADA

by

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A THESIS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled "A Descriptive Study of the Range and Level of Mathematics Courses Offered by the Institutes of Technology in Western Canada", submitted by Leslie Michael Morgan in partial fulfilment of the requirements for the degree of Master of Education.

Abstract

The objective of this study was to describe the various mathematics courses in the engineering technologies of the six Western Canadian Institutes of Technology; furthermore to determine the kind of mathematics courses offered to these technologies; and to consider the differences in course contents. The mathematics entrance requirements, and the availability of upgrading programs were also considered.

The level and range of content of the mathematics courses showed very little homogeneity within the related technology groups. There were major differences between the institutes in the degree of specificity of mathematics courses offered to the technologies.

There was uniformity among four institutes of technology in admission requirements. In the case of the two Alberta institutes of technology, admission requirements varied from Grade XII mathematics to Grade XI mathematics.

There was no uniformity found in upgrading courses. The Alberta institutes of technology have the most highly developed upgrading programs for the prospective students. Manitoba and Saskatchewan follow with less provision for the prospective student. There was no upgrading program found at the British Columbia Institute of Technology.

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Chapter 1

Orientation to the Problem

The inception of the Technical and Vocation Training Assistance Act of 1960 accelerated the introduction of the vocational program into the secondary schools and provided the funds necessary for the building of institutes of technology in the provinces.

The Act of 1960 provided federal assistance in a number of programs. The study at hand deals with the engineering technician training program only. The institutions involved either partly or completely with this program are grouped under the name of institutes of technology.

The development of the institutes of technology in Canada was rapid and many of these institutions were built in a relatively short interval of time. Under the terms of the British North America Act of 1867, legislative responsibility for education was placed in the hands of the provinces. As a result each province has developed its own unique system of education. Probably the only common element among the institutes is that they are all post secondary educational institutions offering terminal education. These institutes of technology are not identical: they are, perhaps, similar to each other in terms of admission requirements, the courses offered, the depths of coverage of topics and/or the extensiveness of training in

the different disciplines.

With regard to mathematics, there has been no specific effort put forward by either the federal or the provincial authorities to prescribe the content of the mathematics courses offered at the institutes of technology. As a consequence, there are some differences among the mathematics courses offered to a particular technology in the different institutes. These differences might be:

1. in the number of instructional hours
2. in the range of topics
3. in the admission requirements
4. in the limits and the number of mathematics courses offered to the technologies.

For instance, it is probable that the mathematics courses offered to drafting technology students at the Northern Alberta Institute of Technology are not identical with the mathematics courses offered to the drafting technology students at the Southern Alberta Institute of Technology.

The differences between, or the similarities among, the mathematics courses should be useful information for the heads of the mathematics departments at the different institutes. Such information could provide the basis for student transfer from one institute to the other. It could also be used by the mathematics departments of institutes of technology to determine the degree of emphasis placed on mathematics by the various institutes. The range and

the level of the mathematics courses could be compared and some conclusions could be drawn.

The Statement of the Problem

A description of the range and level of mathematics courses, admission requirements, mathematics upgrading programs, as applied to the engineering technician training programs offered by Western Canadian Institutes of Technology was not available.

The Objectives of the Study

The objective of this study is to describe the various mathematics courses as applied to the technician training program in the engineering technologies of the Western Canadian Institutes of Technology.

The questions to be answered in this study are:

1. What kind of mathematics courses are offered to the engineering technologies by the Western Canadian Institutes of Technology?

2. What are the differences in content, as determined on the basis of the course content descriptions, between the mathematics courses offered to the same technologies at the different institutes?

3. How much instructional time is allocated to the different mathematics courses by the technologies at the different institutes of technology?

4. What are the mathematics entrance requirements

for each technology in the Western Canadian Institutes of Technology?

5. What kind of mathematics upgrading programs are provided by the various institutes of technology?

Delimitations

This study is delimited to:

1. The field of post-secondary education, specifically to the institutes of technology.

2. The mathematics courses in the engineering technologies.

3. The Western Canadian provinces, that is, Manitoba, Saskatchewan, Alberta and British Columbia.

Limitations

The study is subject to the following limitations:

1. The engineering technologies are limited to the listings given in the calendars of the institutes of technology on the one hand, and to the engineering technologies stated by the heads of the departments of mathematics on the other.

2. The mathematics course content is limited to the descriptions found in the institute calendars.

3. The accuracy of the mathematics course descriptions is limited to the calendars issued prior to the date of April 30, 1972.

Assumptions

It is assumed that:

1. The course titles and the course content descriptions in the institute calendars are accurate and up-to-date.

2. In the course content descriptions, terminology generally accepted by mathematicians is used.

3. The course content as stated in the calendars is covered during the allotted time.

4. The mathematics course content descriptions refers to the use of the same terminology, conventions, principles, and generalizations.

5. On the basis of the course descriptions, as stated in the calendars, a comparison of mathematics courses content can be made.

Significance of the Study

It has been stated that summarized information relevant to the mathematics courses offered to the engineering technologies is not available. This unavailability of important information has been resolved by this study. The range and level of the mathematics courses have been described as applied to the engineering training program of the Western Canadian institutes of technology. The mathematics admission requirements and the mathematics upgrading programs have been tabulated. The questions previously stated have been answered, or the data organized

into such a form that the answer can be deduced by the reader. The differences between the mathematics courses offered in the same or similar technologies at the different institutes of technology have been described. The total number of instructional hours spent on mathematics instruction has been summarized.

With the summaries, tabulations and descriptions of differences, essential assistance has been provided to the heads of departments of mathematics, to the curriculum designers, to the administrators of the different institutes, and last but not least to the co-ordinating bodies of institutes of technology. On the basis of the compiled and summarized data, the content of the mathematics courses, their degree of specificity, the number of instructional hours spent on mathematics, and other relevant information can be compared.

Definition of Terms

For the purpose of this study the following definitions are used:

Institute of Technology

A specified post-secondary educational institution with programs averaging two years in length (NAIT Calendar), (Ven, 1964, p. 92).

Engineering Technician Training Program

The set of specifically designed technical programs offered at the Institutes of Technology leading to

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

a group of employment opportunities in the major industries (BCIT Calendar 1971/72).

Technology (Aeronautical engineering, Architectural, etc.)

Specifically designed curriculum with an emphasis upon mathematics, science and applied technology (Barlow, 1967).

Programs of Study

The list of technologies offered at the institutes of technology.

Technician

Graduate of an institute of technology, having sufficient background to be able to work effectively as a semi-professional member on the engineering manpower team.

Course

A unit of instruction which may consist of lectures, laboratory experiences, recitations as well as independent study, in a particular subject.

Procedures

The population of this study is limited to the institutes of technology located in Manitoba, Saskatchewan, Alberta and British Columbia. The six institutes are as follows:

1. Red River Community College (RRCC), Winnipeg, Manitoba.
2. Saskatchewan Technical Institute (STI), Moose Jaw, Saskatchewan.
3. Saskatchewan Institute of Applied Arts and

Sciences (SIAAS), Saskatoon, Saskatchewan

4. Southern Alberta Institute of Technology (SAIT), Calgary, Alberta

5. Northern Alberta Institute of Technology (NAIT), Edmonton, Alberta

6. British Columbia Institute of Technology (BCIT), Burnaby, British Columbia

Data Collection

The Registrar of each institute was contacted by mail and a copy of the 1972-73 calendar of the institute was requested. The calendars have been the source of data for this study.

Data Analysis

From the calendars the following information was collected and compiled:

1. A list of the engineering technologies offered at the institutes.

2. A list of the mathematics courses for each engineering technology.

3. A breakdown of each mathematics course into mathematics topic headings.

4. The institute and technology matrix was prepared. This matrix depicted the technologies and showed the institutes at which these technologies were offered.

Summary

In this chapter the reader has been presented with a background to the study. The problem and the

objectives of the study have been stated. The delimitations and limitations as well as assumptions and the importance of the study have been outlined.

Chapter 2

Review of Related Literature

The purpose of this chapter is to set a background for the study by reviewing the literature related to institutes of technology; specifically, the literature related to the engineering technician training programs on the post-high school level. Technical education, curriculum development in the institutes, suggestions regarding curriculum and the characteristics of the technical student have been considered.

Barlow (1967) describes the nation-wide need for specially trained people in research and development, service, industrial or manufacturing environments. This need became acute after World War II in both the U.S.A. and Canada. The governments of both countries responded to the need by initiating action in the form of legislation to promote and develop technical education.

Technical Education

Technical Education, as Roney (1969) defines it, "is higher education in the sense that it is most effective at the post-high school level (p. 6)." It has a vocational education under-tone because the focus is primarily on occupational needs rather than on studies of the liberal kind. In its most effective form technical education combines elements of higher education and vocational training. Education, as Babb (1971) points out, "... is technical, if the curriculum, with its objectives, is designed to place

proper emphasis on the theory courses as well as on the applied courses (p. 8)". Technical education, as Babb (1971) further suggests, "... is designed to take advantage of the mathematical process and does not attempt to avoid it (p. 8)."

Fibel (1969) considers technical education from the point of view of the characteristics of the graduate. He states that the segment of occupational education which prepares graduates for semi-professional, or technician level jobs is the one which is called technical education. Technical education as Fibel (1969) points out has become a predominant feature of the two-year college occupational offerings in the United States as well as in Canada.

Technical Education and Industry

To the traditional, discipline-structured educational format, Aldridge (1960) recommends in his article an alternative in the form of goal-oriented learning experiences in order to provide "... the education which will create a career, not a job, for the technician (p. 307)." Industry seems to agree with this premise. As Fellows (1969) writes, "industry demands that technical education should develop a way of life, not an attitude of snobbery (p. 10)." Industry wants and expects, as it is later stated by Fellows (1969), that the educational development of the student be logical and consistent,"... and that the individual be as proud of his talent and application

as is the musician, the artist, or the liberal arts major (p. 9)."

The need for technicians is more evident in industry than in other occupational fields. Roberts (1965) states in his book that it is difficult to determine the ratio of technicians to scientists and engineers because of differences of definition. He also states that there are variations in this ratio among different industries. He estimates that "...there will be a need for about two technicians for each scientist or engineer in the immediate future (p. 367)."

Silvius (1971) describes the basic functions of the technician as follows:

> 1. Carries out the details of projects conceived or initiated by professionals such as the engineer, scientist, professor, teacher, doctor, dentist or nurse.
>
> 2. Is able to turn the theories and ideas, drawings and doodles of the professionals like scientists and engineers into workable products and processes.
>
> 3. Helps to translate ideas and discoveries through an application of scientific principles and modern production processes into useful products and services.
>
> 4. Holds a key position on the team with other professionals (such as engineers, scientists, doctors, professors, nurses and teachers), craftsmen, and other technicians to undertake the problems of industry, research, education and other forms of human endeavor.
>
> 5. Is competent in techniques being applied with one or more methods and in the details of a procedure essential to expertness and application in making computations, performing laboratory

> tests and writing reports; or builds, supervises and controls the machines in plants and offices (p. 7).

As reported by Silvius (1971), the U.S. Office of Education in 1962 developed for the graduate of technical education the following occupational criteria based on recommendations from advisory committees and man power study reports by the Department of Labor and the National Science Foundation:

> 1. Facility with mathematics; ability to use algebra and trigonometry as tools in the development of ideas that make use of scientific and engineering principles; an understanding of, though not necessarily facility with, higher mathematics through analytical geometry, calculus, and differential equations, according to the requirements of the technology.
>
> 2. Proficiency in the application of physical science and principles, including the basic concepts and laws of physics and chemistry that are pertinent to the individual's field of technology.
>
> 3. An understanding of the materials and processes commonly used in the technology.
>
> 4. An extensive knowledge of a field of specialization with an understanding of the engineering and scientific activities that distinguishes the technology of the field. The degree of competency and the depth of understanding should be sufficient to enable the individual to do such work as detail design using established design procedures.
>
> 5. Communication skills that include the ability to interpret, analyze and transmit facts and ideas graphically, orally and in writing (p. 8).

Frank (1968) is in general agreement with the above quotations. He emphasizes that "... technical education is sharply mission-oriented with a commitment already made to

a definite area of occupation or career (p. 2)..." Further on he turns specifically to mathematics and says,

> ... the need for strengthening the learning of mathematics and science for technical students, it is essential that, for both, the major emphasis should be on working in depth on relatively limited but relevant areas or topics rather than on attempting 'coverage' of a wide range of material. Rather than teaching mathematics and science as separate entities and then expecting students to apply what they have learned to practical problems and situations, one should fashion an operation in which both the need and relevance of mathematics and science emerge from project-type missions that are central to the main thrust of the technical education program. Technicians must manipulate and deal with real operational devices and systems; hence, practical experience with these should precede, or at least be concurrent with, the learning of mathematics and science (p. 2).

The Institutes and Industry

The Principal's Report (1960) states that "it is a cardinal principle in vocational education that industry, labor and the school must enjoy the closest possible liaison (p. 1)." This of course, places upon the administration of the institute the responsibility of making recommendations for program offerings. These program offerings, as further stated in the Principal's Report, should meet the realistically determined needs of employers and employees.

In order to determine whether the needs of employers justify the establishment of technology programs at the institute, the usual procedure is to appoint advisory committees for each technology. As Miller (1969) states, an advisory committee, in the initial stages of

establishing a technology, is usually given two charges, The first one is to determine whether the need justifies establishing the program. The second task is to develop a preliminary curriculum.

The Principal's Report (1960) recommended the appointment of an advisory council in the initial stages of the development of NAIT. The report states that the responsibilities of this advisory body are:

> (a) To act as a liaison between school and industry, school and business, school and labor, and in general, school and community.
>
> (b) To advise the school administration relative to school policy program developments, effectiveness of programs, etc.
>
> (c) To encourage the managerial side of industry to be concerned with the product of the school.
>
> (d) To act as consultants in the development of an effective evening division and adult education programs (p. 7).

The use of advisory boards as an advising body is a common practice with the institutes of technology. The lists of the advisory committees are part of every one of the six institutes' calendars. The use of advisory boards as an advising body is not new. Simon (1962) states in his research paper that as early as in 1926 advisory boards were established in Calgary to assist the staff of

SAIT in its efforts to relate instruction to the needs of the province. The most important functions of the advisory committees, as stated by Lowe (1963), are to keep all courses revised and up-to-date, to maintain liaison between industry and the institute, and to advise with respect to curriculum and content of the courses. Tingley (1970) points out an interesting trend in the advisory committees, that is:

> One trend that has been noted is that advisory committees tend to support the aims of general education in their statements; however, the hiring practices of industry, from which the committees are drawn, tend to favour the specific technical skill possessed by graduates over achievement in general studies (p. 15).

The president of SAIT (Calendar) in his message to the students reassures them that

> SAIT's programs and laboratories are continually updated not only by instructors with professional education and practical experience but also by experts direct from business, industry and government who serve on SAIT's advisory committees. (P. 4).

Miller (1969) and Koschler (1969) both report that in the United States the two year colleges, which are similar to our institutes of technology, rely on advisory committees to the same degree as the Western Canadian Institutes of Technology.

General Co-ordinating Bodies

Final approval of courses of programs is done by the provincial government, as stated in the Principal's Report (1960, p. 6). Establishing new technologies, as

Simon (1962, p. 276) reports, requires the approval of the Provincial Government. However, not only the provincial government but also the federal government has some say as to the lines along which an institute is being developed. Until March 31, 1963 the federal government, under the Technical and Vocational Training Assistance Act of 1960, provided for seventy-five percent of the capital expenditures for technical and vocational training facilities. After March, 1963, it provided fifty percent without the limit of a quota allotment (Annual Report, 1961). This Act was in effect through the Technical and Vocational Training Agreement from April 1, 1961 to March 31, 1967 (Klopoushak, 1969, p. 29).

The co-ordinating bodies for institutes of technology in the Western provinces are as follows:

For Manitoba, as stated in the RRCC calendar, the institution is under the general direction of the Department of Youth and Education, and is under the co-ordinating effect of the Community College Division.

For Saskatchewan, the "Directory of Universities and Colleges in Canada" (1969, p. 33) states that the institutes of technology are administered by the Department of Education. This statement is in agreement with the calendars of both STI and SIAAS.

Alberta's institutes of technology are administered by the Department of Advanced Education (SAIT and NAIT Calendars).

In Canada's most westerly province, British Columbia, the British Columbia Institute of Technology at Burnaby is under the general direction of the Department of Education. As Martin (1970, p. 15) points out, the institution is also under the co-ordinating effect of the Advisory Board (financial), and an Academic Board. The Academic Board's responsibility is with academic standards in British Columbia.

Martin (1970, p. 9) states that the co-ordination of post-secondary education in Canada is characterized by different, generally provincially inspired patterns, According to Harris (1969) "... higher education in Canada neither is nor ever has been all of a piece (p. 9)."

Curriculum Development

Harris (1969) suggests that the total instructional program should come to focus in the person of the president of the institution. Curriculum design should be a cooperative faculty effort. This curriculum design should take into consideration, as Koschler (1969) suggests, the provincial and regional needs. Koschler (1969, p. 3) states in the same article that "10 to 20 percent of curriculum should be identified quite closely with immediate industries".

In some schools, as Miller (1969) states, the assistant dean is responsible for the curriculum. In other states, as Koschler (1969) shows, curriculum is

developed and issued by the state education department. The same article also states that the program director, the dean of occupational programs or department head, and teachers are primarily responsible for establishment and development of curriculums.

Curriculum development is done differently in some schools as stated by Dwyer (1966):

> The development and maintaining of curriculums designed to provide a student with knowledge and skills for a specific occupation are extremely difficult. The usual procedure is to overhear a comment by someone from the Chamber of Commerce, an industrial committee, or an agency. A job is identified; employees are scarce. The community college then conducts a survey or entices the interested group into supplying some statistics. The responsible administrator next discreetly inquires from his colleagues where the program is offered and by what community college. The curriculum is then developed from a catalog by changing course titles and rewording course descriptions. At this point, an advisory committee is formed for the sole purpose of approving the duplicated program which is circulated at the first meeting. The strategic value of such approval is that the college board of trustees is almost mandated to endorse this new venture by the college. The advisory committee serves the further function of relieving the administrator of all responsibility for the program if students don't clamor for enrollment in the new curriculum (p. 139).

It is stated in the Principal's Report No. 5 (1961) that the duty of the Office of the Supervisor, Technical Division "... involves improvement of instruction, curriculum development, and staff organization within the Division ..." Thornton (1960) assigns the responsibility of curriculum development to a Dean of Instruction, who

has the same position in the administrative structure as the Supervisor of a Division at NAIT. Thornton states that

> It is the responsibility of the Dean of Instruction to promote continuous review of the offerings of the college to the end that the quality of the faculty, the organization of the courses, and the auxiliary services of the college may all combine to provide excellent educational opportunity for all classes of student (p. 169).

Darnes (1968) summarizes the general situation in curriculum development when he states: "Several states have legislated the curriculum of the junior college, while others have seen fit to leave the development of the curriculum up to the individual campuses (p. 610)".

Technical Curriculum and General Education

General education is defined by Tingley (1970) as follows:

> General education refers to courses in oral or written communication, supervision, industrial, sociology, economics, national and international affairs, labour relations, literature, art and national culture (p. 4).

While Tingley's definition is closely related to subjects, Thornton's (1960) definition of general education refers to programs of education specifically designed to prepare young people for responsibilities which they share in common as citizens. Thornton defines general education as

> That part of education which prepares the student to assume his roles as an individual, as a member of a family and as a citizen. While it may contribute to his choice of occupation and to his

> success as a worker, vocational skills are not its main objective. It is called 'general' because its purposes are conceived to be common to all men; it is that part of the total collegiate offering which is concerned with men's likeness rather than with their divergent interests. It intends to assist the student to feel intellectually and psychologically at home in a world which makes new economic, social, civic, psychological, spiritual and intellectual demands upon him (p. 198).

General education, as stated by Venn (1964, p. 93) receives little attention in most technical institute curricula. Further on, Venn (1964, p. 93) states that the original technical schools saw their goal as the most thorough possible proparation of the student in his chosen field of technology, and these schools did not believe a two-year curriculum left time for general education courses.

The technician's training, as Dobrovolny (1969) points out, must provide the technical and scientific background to enable the technician to function as a liaison person between the engineer and the craftsman on the one hand, and to prepare him to keep abreast of developments in technology throughout his career, on the other. This same author suggests that the curriculum should have three major groups of courses, such as: basic science and mathematics, non-technical, and techology courses.

Thornton (1960, p. 189) makes several suggestions with respect to the distribution of general versus specialized courses in the curriculum. He recommends that the program should include 40 percent general courses and 40 percent specialized study. He suggests that 20 percent of the total study be reserved for elective courses.

Thornton (1960) cites another analysis which proposes one-half in occupational education, one-third in required general education, and the remaining one-sixth for elective courses.

Harris (1964, p. 39) proposes the following distribution of courses in the curriculum:

Mathematics	13.5
Science for technicians	13.5
Technical specialty courses	41.0
Supporting technical courses	8.0
General education courses	24.0

where the numbers are in per cent of the total semester credit hour requirement.

Dobrovolny (1970) prefers a distribution of 50 percent in the occupational specialty, 25 percent in mathematics and science, and 25 percent in general education courses. Dobrovolny (1970, p. 11) proposes the following curriculum for Drafting Technology:

Basic Science Course	Contact Hour
Mathematics	165
Physics	165
	330

Non-Technical Courses	Contact Hour
Communications	99
Humanistic-Social Studies	132
Non-Technical Elective	33
Orientation & Seminar	44
	308

Technology Courses		Contact Hour
Technical Skills		176
Technical Specialties		825
Technical Electives		110
		1111
	Totals	1749

Dwyer (1966) states in his study that:

> ... general education for the non-transfer student has been at best an adaptation of the liberal arts tradition. New approaches have been developed for the study of physics, biology, and mathematics, but the real challenge in curriculum development is in a new approach to the teaching of history, sociology, psychology and the humanities for the non-transfer students. I would be unfair to the few, isolated, dedicated teachers who have struggled with this problem if I did not acknowledge their efforts in several of the areas of general education, but such programs are piecemeal and are usually developed in spite of, not because of the practice and philosophy of the college (p.139).

Venn (1964, p. 93) states that general education receives little attention in most of the curricula of the institutes of technology. He states that many of the institutions do not include general education content because they do not have the staff or academic facilities. Venn (1964, p. 94) cites a study in which 48 institutes provided an average of 9.6 percent of the total time (contact hours) for general education.

Mathematics in the Curriculum

Fellows (1969) in his study shows how industry sees the importance of mathematics in the technical education curriculum. He states that "mathematics, industrial-

ists believe, is the basis for scientific understanding and hopefully provides a foundation for logical thinking (p. 10)."

Koschler (1969) sees the importance of mathematics, among other subjects, to provide for the students so that necessary studies can be pursued as changes develop.

Babb (1971) requires mathematics in the curriculum for electronics technicians because the electronics theory courses require a mathematical process since equations are written for circuit models and these equations are evaluated in order to determine the response of given circuits. He states however that

> ... the theory courses require little more than a working knowledge of algebra, including complex numbers and the concepts of trigonometry. The more advanced topics in mathematics are needed to heighten the appreciation and understanding of the mathematical process. But they are not actually needed for the analysis of circuits. LaPlace transforms, for example, reduce the complete analysis of circuits to an algebraic problem. The student only needs to know how to use the LaPlace transforms. Selected topics in calculus and differential equations are needed for derivations, not for analysis. In any case, these advanced topics are essential for self-education (p. 8).

Frank (1968) suggests in his paper that for technical students the mathematics should place relatively heavy emphasis on:

> a) Approximation methods; estimation of errors or effects of omitted parameters; orders of magnitude and 'ball-park' estimates;
>
> b) Elementary statistics; accuracy versus precision; and significant figures;
>
> c) Graphical representations and solutions;

> d) Determination of upper and lower bounds of acceptable solutions relative to acceptable tolerances, performance characteristics and so forth (p. 2).

Frank further on states that a two semester technical mathematics course should precede the sophomore mathematics courses. Such a sequence would, states Frank (1968), accomplish two purposes:

> (1) It will give the potential engineering technician student the preparation he needs for applied calculus and other advanced courses in the sophomore year, and (2) it provides a necessary and sufficient mathematical background for the industrial technician to build upon as he completes his formal technical training and moves on into a technician job (p. 3).

Technical curriculum should be strengthened, suggests Farley (1968)

> ... by constantly searching for new teaching methods, condensing some courses, dropping outdated ones, and frequently updating the curriculum. New courses which should be considered are in the computer-related areas. Computer science and computer programming are becoming more important as more industry introduces computers to aid their teaching staff (p. 7).

In addition to statements of general educational requirements for various technologists, some studies have been made to show the relation of specific subject matter areas to various technical occupations. Kleintjes (1969) (p. 102) states that the following mathematical topics are considered to be essential to the construction engineering, architectural draftsman, estimator, highway engineering technicians and to the surveyor:

Algebra through quadratic equations
Trigonometry of the right and oblique angle
Analytical geometry and mathematical analysis
Plane geometry
Structural computations and estimating
Introduction to calculus (p. 102).

Structural computations and estimating are considered to be advisable for a surveyor; similarly, introduction to calculus is advisable only for the construction engineering technician.

In the same book Kleintjes (1969) states that Mechanical Technology has "6 credit hours of mathematics (p. 110)", and Industrial Technology has "4 units of calculus (p. 111)".

Roper (1966, p. 5) in his survey of the mathematics courses of the Canadian institutes of technology has found the following distribution of mathematics periods amongst the academic years:

	1st Year	2nd Year	3rd Year	% of Total Time Spent on Math.
Ontario Institute	5/30	5/30	4/30	15.5 %
Manitoba Institute	5/34	3/34	2-year programme	12.5 %
Prairie Institute	5/30	4/30	2-year programme	15 %
Quebec Institute	7/30	3/30	1/30	12 %
Western Institute	5/35	5/35	2-year programme	14 %

All technical curricula have a mathematics and science base. This mathematics and science core, of course, varies from curriculum to curriculum and discipline to discipline. Because of the specialty of the curriculum and the students, this mathematics should be technical mathematics. As Dobrovolny (1970) states, these technical mathematics courses are designed for the related technologies. They include topics such as trigonometry, analytical geometry and calculus. He suggests that "the teacher should articulate the topical coverage in the respective math and science courses with the topics being covered in the technical specialty courses (p. 1)".

Mathematics curriculum must satisfy the requirements of the particular technology and the approach to the mathematical topics must be suitable to the particular student body.

The Technology Student

Dobrovolny (1970) states that "the temperament of the technical student, as well as his motivation, is different from the liberal arts student (p. 1)". The technical student is interested in the application rather than the derivation of scientific principles; he is interested in problem-solving techniques; he is oriented to things rather than to theory; he is mission oriented, states the same author further on.

Fellows (1969) describes the technical student by comparing him to the engineer, "where the engineer thinks in terms of 'why' something is done, the engineering technician thinks in terms of 'how' to do the task (p. 10)". He further on suggests that the interest of the technical student in abstract knowledge may be limited.

Aldridge (1970) gives the following description of the typical technical student: he lacks self-confidence, he is less mature emotionally and psychologically than the engineering science student, and he comes from the lower socio-economic levels.

Aldridge (1970) and Dobrovolny (1970) among others suggest that the mathematics content must be tied as closely as possible to the technical studies of the students.

Roper (1966) states the opinion of the sub-committee on mathematics from the point of view of the students of technology:

> In view of the rather brief training period of the technician compared with say the university engineer or scientist, it is necessary to teach an applied mathematics course as closely related to the student's needs as possible. There is very little time in the institute programmes for students to do very much work on their own in laboratories or in tutorial settings. It is the experience of the teachers of mathematics at institutes of technology that the mathematics topics have, at all times, to be introduced and related to the students particular knowledge and interests in technology and that to expect students to develop their own applied problems from a course in pure mathematics is unreasonable. (p. 7).

This chapter has dealt with the information found by the researcher with respect to: (1) technical education,

and how technical education is seen by industry, (2) how the institutes are affected by industry, (3) provincial and federal co-ordination, (4) curriculum development, (5) the proportion of general education in the technical curriculum, (6) the mathematics curriculum, and finally (7) the characteristics of the technical student. In some cases, a lack of agreement was found, for example, in curriculum development, the number of hours and the essential topics in mathematics instruction. In other cases, a general agreement was the underlying characteristic, for instance the principle that the mathematics courses must be applied and closely related to the students' needs. Agreements and disagreements, and in general, the findings were presented with the least possible distortion.

Chapter 3

Procedure

The procedures used in the design of the study are outlined in this chapter and include the population data collection, and the method of treating the data.

The Population

The population in this study consists of the six Western Canadian Institutes of Technology. These institutes are located in Manitoba, Saskatchewan, Alberta and British Columbia. The six institutes are as follows:

1. Red River Community College (RRCC) Winnipeg, Manitoba.
2. Saskatchewan Technical Institute (STI) Moose Jaw, Saskatchewan.
3. Saskatchewan Institute of Applied Arts and Sciences (SIAAS), Saskatoon, Saskatchewan.
4. Southern Alberta Institute of Technology, (SAIT), Calgary, Alberta.
5. Northern Alberta Institute of Technology (NAIT), Edmonton, Alberta
6. British Columbia Institute of Technology (BCIT), Burnaby, British Columbia.

Data Collection

The Registrar of each institute was contacted by mail and in some cases by telephone, and a copy of the 1972-73 calendar of the institute was requested. The study was based on information contained in the calendars of the institutes of technology in Western Canada and the results of a questionnaire.

The questionnaire was designed to give answers to questions found essential to this study and not necessarily available in the calendars of the institutes of technology. The head of each mathematics department was contacted by mail, and responses regarding admission requirements, credit, mathematics upgrading programs, and a list of the engineering technologies was requested.

From the calendars and the questionnaire the following information was collected and compiled:

1. A list of the engineering technologies offered at the institutes.

2. A list of the mathematics courses for each of the engineering technologies.

3. A breakdown of each mathematics course into mathematics topic headings.

4. The institute and technology matrix was prepared. This matrix depicted the technologies and showed the institutes at which these technologies were offered. The following example was prepared to exhibit the basic construction of the table:

Technology	RRCC	STI	SIAAS	SAIT	NAIT	BCIT
Aeronautical Engineering				X		
Air Conditioning				X		
Air Conditioning & Refrigeration					X	
Architectural		X			X	
Etc.						

5. The same table was repeated except that in this matrix the entries were the mathematics admission requirements.

6. The same institutes and technologies table was used to show the total number of mathematics instructional hours for each technology.

7. A summary of the institutes and available mathematics upgrading courses were prepared.

Data Analysis

On the basis of the matrices and tables the data was analyzed with regard to the following points:

1. Differences in the mathematics course content between the institutes of technology with respect to the technologies.

2. The number of hours of mathematics instruction for each technology.

3. The existence and range of daytime mathematics upgrading programs at the different institutes.

On the basis of the analysis, conclusions were drawn and recommendations made.

Chapter 4

Analysis of Data

In this chapter the findings are reported and data is presented in summarized form. The second section of this chapter contains an analysis of the data.

The List of the Engineering Technologies

This list contains all those engineering technologies which were included in the questionnaire by the heads of the mathematics departments of the institutes of technology, except Computer Technology and Biological Sciences Technology. It was found that the Computer Technology was not only business oriented but also part of the business division and not of the technology division of the institute. The only exception was SAIT, where this technology is part of the technology division. These different orientations of this technology at the different institutes made the comparison unrealistic and the technology was omitted from the listing.

Biological Sciences Technology is offered at BCIT with three options and offered at NAIT with two options. The head of the mathematics department of NAIT has not listed this technology; therefore it was omitted from the listing. The complete list of the engineering technologies included in this study are presented in Table 1. In this table the entries show the Institute of Technology at which the particular technology is offered.

TABLE 1

THE ENGINEERING TECHNOLOGIES AND THE INSTITUTES OF TECHNOLOGY

Technology	RRCC	STI	SIAAS	SAIT	NAIT	BCIT
Aeronautical Engineering				X		
Air Conditioning Engineering				X		
Air Conditioning and Refrigeration					X	
Architectural		X			X	
Bio-Chemical	X					
Building	X					X
Building Construction					X	
Chemical	X			X	X	
Chemical Engineering				X		
Chemical Research					X	
Civil	X	X			X	
Civil and Structural						X
Design and Drafting	X					
Drafting		X			X	
Earth Resources, Coal					X	
Earth Resources, Petroleum					X	
Environmental Services						X
Electrical	X	X			X	X
Electrical Engineering				X		
Electronics	X	X			X	X
Electronics Engineering - Communications				X		
Electronic Engineering - Industrial				X		
Electronics Engineering				X		
Extractive Metallurgy						X
Engineering Graphics				X		
Environmental - Architectural				X		
Environmental - Building Development				X		
Forest					X	
Forestry						X
Forestry - Fish and Game						X
Forest Resource - Wood						X
Forest Resource - Pulp and Paper						X
Gas					X	
Heat and Power	X					
Industrial Engineering				X		
Industrial Chemical			X			
Industrial Chemistry						X
Industrial Production					X	
Instrumentation	X				X	
Instrumentation and Systems						X

TABLE 1 (Continued)

Technology	RRCC	STI	SIAAS	SAIT	NAIT	BCIT
Materials Testing and Metallurgy					X	
Mechanical			X			
Mechanical Engineering				X		
Mechanical Production						X
Mechanical Design						X
Metallurgical						X
Mining						X
Natural Gas and Petroleum						X
Petroleum - Production				X		
Petroleum - Geology				X		
Petroleum - Reservoir				X		
Physical Metallurgy						X
Plastics					X	
Pollution Treatment						X
Power Engineering				X		
Production	X					
Renewable Resources			X			
Structural	X					
Structural Engineering				X		
Surveying	X	X		X	X	X
Surveying - Photogrammetry						X
Telecommunications					X	
Water Sciences			X			

The List of the Mathematics Courses

The mathematics courses are stated for each technology with the particular institute's subject coding system. The data is presented in table form. For each school a separate table was prepared. In the tables, the same title headings - mathematics, calculus, statistics, descriptive geometry, basic technical mathematics, etc. - were used as in the calendars.

In Table 2 the technologies and mathematics courses are summarized for RRCC.

In Table 3 and Table 4 the technologies and mathematics courses are tabulated for STI and SIAAS.

Table 5 and Table 6 contain the technologies and mathematics courses for SAIT and NAIT respectively.

In Table 7 the technologies and mathematics courses are summarized for BCIT.

RRCC, STI, SIAAS, and BCIT are operating on the semester system. Four semesters complete the course of study for the student of a technology. SAIT and NAIT are operating on the quarter system. As a rule, 6 quarters complete the course of study for the student of a technology.

TABLE 2

MATHEMATICS COURSES BY TECHNOLOGIES AND SEMESTERS
RED RIVER COMMUNITY COLLEGE

Technology	First and Third Semester	Subject Code	Second and Fourth Semester	Subject Code
Chemical	Mathematics Calculus	MATH-107 MATH-307	Mathematics	MATH-207
Biochemical	Mathematics Calculus	MATH-107 MATH-312	Mathematics	MATH-207
Building	Mathematics	MATH-109	Mathematics	MATH-209
Civil	Mathematics Mathematics	MATH-109 MATH-309	Mathematics	MATH-209
Design and Drafting	Mathematics	MATH-109	Mathematics	MATH-209
Electrical	Mathematics Mathematics	MATH-102 MATH-303	Mathematics Mathematics	MATH-202 MATH-403
Electronic	Mathematics Mathematics	MATH-102 MATH-302	Mathematics Mathematics	MATH-202 MATH-402

TABLE 2 (Continued)

Technology	First and Third Semester	Subject Code	Second and Fourth Semester	Subject Code
Heat and Power	Mathematics Mathematics	MATH-106 MATH-306	Mathematics	MATH-206
Instrumentation	Mathematics Mathematics	MATH-102 MATH-305	Mathematics	MATH-202
Production	Mathematics Mathematics	MATH-106 MATH-306	Mathematics Statistics	MATH-206 MATH-427
Structural	Mathematics	MATH-109	Mathematics	MATH-209
Surveying	Mathematics Mathematics	MATH-109 MATH-310	Mathematics	MATH-209

TABLE 3

MATHEMATICS COURSES BY TECHNOLOGIES AND SEMESTERS
SASKATCHEWAN TECHNICAL INSTITUTE

Technology and Institute	First and Third Semester	Subject Code	Second and Fourth Semester	Subject Code
Architectural	Mathematics Mathematics	M20.14 M20.33	Mathematics Mathematics	M20.24 M20.42
Civil	Mathematics Mathematics	M30.14 M30.33	Mathematics Mathematics Computer Programming	M30.24 M30.42 CP30.42
Drafting	Mathematics Mathematics	M60.14 M62.33	Mathematics Mathematics	M60.23 M62.43
Electrical	Technical Mathematics Computers and Programming Mathematics	M40.16 CP40.32 M40.32	Calculus	M40.24

TABLE 3 (Continued)

Technology and Institute	First and Third Semester	Subject Code	Second and Fourth Semester	Subject Code
Electronics	Mathematics	M50.16	Mathematics	M50.25
	Basic Programming	BP50.11		
	Mathematics	M50.32		
Survey	Mathematics	M60.14	Mathematics	M60.23
	Descriptive Geometry	DG60.13	Descriptive Geometry	DG60.23
	Mathematics	M64.34	Mathematics	M64.44

TABLE 4

MATHEMATICS COURSES BY TECHNOLOGIES AND SEMESTERS
SASKATCHEWAN INSTITUTE OF APPLIED ARTS AND SCIENCES

Technology and Institute	First and Third Semester	Subject Code	Second and Fourth Semester	Subject Code
Industrial Chemical	Trig.and Introd. Calculus	MA1224	Statistics	M2523
	Computer Program.	CP3084		
	Calculus	MA3234		
Mechanical	Technical Mathematics	MA1224	Calculus	MA2233
			Computer Science	CS4072
Water Sciences	Technical Mathematics III	MA1224	Calculus	MA2234
	Statistics I	MA3523	Statistics II	MA4533

TABLE 5

MATHEMATICS COURSES BY TECHNOLOGIES AND QUARTER
SOUTHERN ALBERTA INSTITUTE OF TECHNOLOGY

Technology	First and Fourth Quarter	Subject Code	Second and Fifth Quarter	Subject Code	Third and Sixth Quarter	Subject Code
Air Conditioning Engineering	Algebra	ALG-002	Trigonometry Industrial Computer	TRIG-002 CT-206	Mathematics	CALC-001
Chemical	Pre-Calc Trig	TRIG-002			Calculus	GEOM-002
Chemical Engineering	Fortran Pre Calc Trig Calculus	CT-100 TRIG-002 CALC-003	Calculus Differential Equations	GEOM-002 CALC-004	Calculus	CALC-002
Electrical Engineering	Algebra Calculus Computer Techniques	ALG-002 CALC-002 CT-206	Trigonometry Fortran	TRIG-002 CT-100	Calculus	GEOM-002
* Electronics Engineering Technologist (Communications Pattern, and Industrial Electronics Pattern).	Mathematics I Applied Math III	MATH-115 ENT-450	Math. II Applied Math. I	MATH-125 ENT-250	Applied Math. III	ENT-360

TABLE 5 (Continued)

Technology	First and Fourth Quarter	Subject Code	Second and Fifth Quarter	Subject Code	Third and Sixth Quarter	Subject Code
Engineering Graphics	Trigonometry Fortran I Plane Geometry	TRIG-001 CT-100 GEOM-001	Calculus	CALC-001		
Environmental Architectural	Trigonometry Algebra	TRIG-002 ALG-002	Calculus	GEOM-002		
Environmental Building Development	Trigonometry Algebra Fortran	TRIG-002 ALG-002 CT-100	Calculus Computer Applications	GEOM-002 CT-207		
Industrial Engineering	Algebra Statistics Calculus (Option)	ALG-001 MATH-980 CALC-002	Trigonometry Fortran	TRIG-001 CT-100	Statistics Calculus	STAT-001 CALC-001
Mechanical	Trigonometry Calculus Calculus	TRIG-002 GEOM-002 CALC-003	Calculus	CALC-002	Fortran Statistics	CT-100 STAT-001
Petroleum Production	Trigonometry Calculus Differential Equations (Option)	TRIG-002 GEOM-002 CALC-004	Calculus Fortran Adv. Calc. (Option)	CALC-002 CT-100 ADVC-001	Calculus Computer Statistics	CALC-003 CT-208 STAT-001

TABLE 5 (Continued)

Technology	First and Fourth Quarter	Subject Code	Second and Fifth Quarter	Subject Code	Third and Sixth Quarter	Subject Code
Petroleum Geology	Mathematics courses and options are identical to petroleum production					
Petroleum Reservoir	Mathematics courses and options are identical to petroleum production					
Power Engineering	Trigonometry Calculus	TRIG-002 GEOM-002	Calculus Fortran	CALC-002 CT-200	Calculus Computer Techniques	CALC-003 CT-217
Structural	Trigonometry Algebra	TRIG-001 ALG-001	Calculus	CALC-001	Fortran	CT-100
Surveying	Trigonometry Geometry Spherical Trigonometry Data Processing	TRIG-002 GEOM-001 TRIG-003 CT-311	Calculus Calculus Statistics	GEOM-002 CALC-003 STAT-001	Calculus Calculus	CALC-002 CALC-004
Aeronautical Engineering Third Year - First two years are identical to Mechanical	Advanced Calculus	ADVC-001	Advanced Calculus	ADVC-002	Advanced Calculus	ADVC-003

* The ENT courses are omitted from further consideration since they are electronics courses.

TABLE 6

MATHEMATICS COURSES BY TECHNOLOGIES AND QUARTERS
NORTHERN ALBERTA INSTITUTE OF TECHNOLOGY

Technology	First and Fourth Quarter	Subject Code	Second and Fifth Quarter	Subject Code	Third and Sixth Quarter	Subject Code
Air Conditioning and Refrigeration	Technical Math	ASM 100	Technical Math	ASM 201	Technical Math	ASM 302
	Fortran	ASM 470	Statistics	ASM 560		
Architectural	Technical Math	ASM 103	Fortran	ASM 270	Computer Applications	ASM 390
Building Construction	Technical Math	ASM 107	Technical Math	ASM 208		
Chemical	Technical Math	ASM 104	Fortran (Option)	ASM 680		
Chemical Research	Technical Math	ASM 104	Applied Calculus	CHM 580		
Civil	Technical Math	ASM 105	Calculus	ASM 232	Fortran and Statistics	ASM 367
Drafting	Technical Math	ASM 109	Technical Math	ASM 210	Fortran	ASM 380
Earth Resources, Coal	Technical Math	ASM 112	Calculus	ASM 231	Calculus	ASM 341
	Fortran	ASM 472	Computer Applications	ASM 591	Statistics	ASM 662

TABLE 6 (Continued)

Technology	First and Fourth Quarter	Subject Code	Second and Fifth Quarter	Subject Code	Third and Sixth Quarter	Subject Code
Earth Resources Petroleum	Technical Math	ASM 112	Calculus	ASM 231	Calculus	ASM 341
	Fortran	ASM 472	Computer Applications	ASM 591	Statistics	ASM 662
Electrical	Mathematics	ASM 111	Calculus	ASM 230	Numerical Methods	ASM 699
	Fortran and Statistics	ASM 476				
Electronics	Mathematics	ET 100	Calculus 1	ET 200	Calculus 2	ET 300
Forest	Technical Math	ASM 115	Technical Math	ASM 216	Statistics Fortran	FT 252 ASM 372
Gas	Technical Math	ASM 117	Technical Math	ASM 218	Calculus	ASM 332
	Statistics Fortran	ASM 462 ASM 481				
Industrial Production	Technical Math	ASM 121	Calculus	ASM 233	Calculus	ASM 342
	Statistics	ASM 460	Fortran	ASM 580		

TABLE 6 (Continued)

Technology	First and Fourth Quarter	Subject Code	Second and Fifth Quarter	Subject Code	Third and Sixth Quarter	Subject Code
Instrumentation	Technical Math Statistics	ASM 122 ASM 461	Calculus	ASM 234	Calculus	ASM 343
Materials Testing and Metallurgy	Technical Math	ASM 123	Technical Math	ASM 264	Calculus	ASM 334
Plastics	Mathematics	ASM 123	Mathematics	ASM 264	Calculus	ASM 334
Surveying	Trigonometry Spherical Trigonometry Statistics Algebra	ASM 125 ASM 452 ASM 463 ASM 426	Geometry Calculus Fortran	ASM 251 ASM 537 ASM 571	Calculus Computer Applications	ASM 640 ST 681
Telecommunications	Technical Math	ASM 127	Calculus	ASM 236	Calculus	ASM 344

TABLE 7

MATHEMATICS COURSES BY TECHNOLOGIES AND SEMESTERS
BRITISH COLUMBIA INSTITUTE OF TECHNOLOGY

TECHNOLOGY	First and Third Semester	Subject Code	Second and Fourth Semester	Subject Code
Building	Basic Tech. Math	32.101	Calculus I	32.226
Building Environment Service Option	Basic Tech. Math	32.101	Calculus I	32.226
Chemical and Metallurgical Industrial Chemistry Option	Basic Tech. Math Calculus III	32.101 32.306	Calculus I and II Statistics I	32.223 32.454
Physical Metallurgy Option	Basic Tech. Math Calculus III	32.101 32.306	Calculus I and II Statistics I	32.223 32.454
Extractive Metallurgy Option	Basic Tech. Math Calculus III	32.101 32.306	Calculus I and II Statistics I	32.223 32.454
Pollution Treatment Option	Basic Tech. Math Calculus III	32.101 32.306	Calculus I and II Statistics I	32.223 32.454
Civil and Structural	Basic Tech. Math Calculus III	32.101 32.306	Calculus I and II Statistics	32.223 32.454
Electrical	Basic Math Transform Calculus	32.170 32.370	Calculus	32.270
Electronics	Basic Math Transform Calculus	32.170 32.370	Calculus	32.270
Forest Resource Forestry	Basic Tech. Math	32.101	Statistics I and II	32.246

TABLE 7 (Continued)

Technology	First and Third Semester	Subject C ode	Second and Fourth Semester	Subject Code
Forestry Resource, Fish, Game and Parks	Basic Tech. Math	32.101	Statistics I and II	32.246
			Computer Applications	14.351
Forest Resource, Pulp and Paper	Basic Tech. Math	32.101	Calculus I and II	32.223
	Statistics	32.304	Statistics II	32.406
Forest Resource, Wood	Basic Tech. Math	32.101	Statistics I and II	32.246
	Computer Applications	14.351	Linear Programming	14.408
Instrumentation	Basic Tech. Math	32.101	Calculus I and II	32.223
	Calculus III	32.306	Statistics I	32.454
Mechanical, Production	Basic Tech. Math	32.101	Calculus I	32.223
	Calculus III	32.306	Statistics I	32.454
Mechanical, Design	Basic Tech. Math	32.101	Calculus I and II	32.223
	Calculus	32.306	Statistics I	32.454
Mining	Basic Tech. Math	32.101	Calculus I and II	32.223
	Calculus III	32.306	Statistics I	32.454
Natural Gas and Petroleum	Basic Tech. Math	32.101	Calculus I and II	32.223
	Calculus III	32.306	Statistics I	32.454
			Computer Applications	14.351
Surveying	Basic Tech. Math	32.101	Statistics I and Spherical Trigonometry	32.246
	Computer Applications	14.351		
	Calculus I	32.302	Calculus II and Statistics II	32.436

TABLE 7 (Continued)

Technology	First and Third Semester	Subject Code	Second and Fourth Semester	Subject Code
Photogrammetry Option	Basic Tech. Math	32.101	Statistics I and Spherical Trigonometry	32.246
	Computer Applications	14.351	Numerical Methods	32.456
	Calculus	32.302		

The Mathematics Topic Headings

In order to break down the mathematics courses into topic headings, a set of such headings had to be established. This was achieved by the summarization of course outline contents presently used by the Mathematics Section of NAIT. This summarization was supplemented by comparing the topic headings with the texts used by the Mathematics Section. The Mathematics Section is presently using Washington's (1970) book for the pre-calculus and calculus courses. For the statistics courses a manual written by that Section and printed by NAIT is used. All course outlines for the Fortran or programming courses were prepared on the basis of Murril's (1969) book. For specialized courses such as spherical trigonometry, headings found in the calendars were used.

The purpose of the pre-prepared topic headings was to provide a common denominator for the mathematics courses in order to make a comparison possible.

Each calendar contained descriptions of the mathematics courses. Descriptions varied in specificity and amount of detail. An effort was made to find the most suitable topic heading for each of the calendar course descriptions. If the calendar description was very general, references to key mathematical topics were looked for. The process of fitting most of the mathematics courses into the prepared mathematics topic headings was kept as objective as possible.

Table 8 contains the pre-prepared set of mathematical topic headings for pre-calculus and calculus courses.

TABLE 8

MATHEMATICS TOPIC HEADINGS
PRE-CALCULUS AND CALCULUS

Mathematical Topic Heading	Description
Slide Rule	Reading the Slide Rule. Multiplication, division, squares, square roots, combined operations. Trigonometric scales.
Fundamental Concepts and Operations	Numbers and literal symbols. Fundamental laws of algebra. Exponents and radicals. Operations. Equations and formulas.
Functions and Graphs	Functions. The rectangular coordinates. The graph of a function. Graphical solution of equations
The Trigonometric Functions	Angles. Defining of trigonometric functions. Values of trigonometric functions. Interpolation. The right triangle. Applications.
Systems of Linear Equations; Determinants	Linear equations. Systems of two linear equations. Methods of solution. Determinants. Systems of three linear equations; algebraic solutions; determinants.
Factoring and Fractions	Special products. Factoring. Equivalent fractions. Operations. Equations involving fractions.

TABLE 8 (Continued)

Mathematical Topic Heading	Description
Quadratic Equations	Solution by factoring. Completing the square. The quadratic formula.
Trigonometric Functions of Any Angle. Radians.	Signs of the trigonometric functions. Trigonometric functions of any angle. Radians. Arc lengths and areas.
Vectors and Oblique Triangles	Vectors and applications. The law of sines and the law of cosines.
Graphs of the Trigonometric Functions	The graphs of y = a sinx x; y = a sin bx; y = a sin (bx+c). Graphs of the other five trigonometric functions. Applications, motions, alternating current. Composite curves. Lissajous figures.
Exponents and Radicals	Integral exponents. Fractional exponents. Simplest radical form. Operations.
The j - Operator	Imaginary numbers. Complex numbers. Operations. Graphical representation of complex numbers. Polar form. Exponential form. Products, quotients, powers and roots of complex numbers.
Logarithms	Definition. Graphs of $y = b^x$ and $y = \log_b x$. Properties of logarithms. Log. computations. Logarithms of trigonometric functions. Logarithms to bases other than 10. The use of logarithmic paper.
Equations of Higher Degree	Graphical solution of systems of equations. Algebraic solution. Equations in quadratic form. Equations with radicals. Exponential and logarithmic equations. Remainder theorem.

TABLE 8 (Continued)

Mathematical Topic Heading	Description
Equations of Higher Degree (continued)	Factor theorem. Synthetic division. Roots. Rational and irrational roots. Linear interpolation.
Determinants and Matrices	Expansion by minors. Properties of determinants. Matrices, basic operations. Multiplication. Inverse. Matrices and linear equations.
Inequalities	Properties. Graphical solutions. Algebraic solutions. Absolute values.
Variation	Ratio and proportion. Direct, inverse and joint variations.
Progressions	Arithmetic, geometric. Geometric progressions with infinitely many terms.
Trigonometric Identities. Inverse.	Fundamental identities. Sum and difference of two angles. Double-angle formulas. Half-angle formulas. Trigonometric equations. Inverse Trigonometric functions.
Straight Line	Distance formula, slope, equation of the straight line.
The Circle	Definition. Equation of the circle.
Plane Analytic Geometry	The straight line, the circle, the parabola, the ellipse, the hyperbola. Translation of axes. Polar coordinates. Curves in polar coordinates.
Statistics: Error, Confidence.	Probability, frequency distributions, measures of central tendency. Histograms. Standard deviation, normal distribution curve. Fitting of a straight line to a set of points.

TABLE 8 (Continued)

Mathematical Topic Heading	Description
Statistics: Error, Confidence (continued)	Fitting non-linear curves to data.
The Derivative	Limits. Slope. The derivative. The meaning of the derivative. Derivatives of polynomials. Derivatives of products, quotients of functions and power of a function.
Applications of the Derivative	Tangents and normals, curvilinear motion, related rates, voltage, speed, etc. Curve sketching. Maximum and minimum problems.
Integration	Differentials. Inverse differentiation, the indefinite integral. Area under a curve. The definite integral. Numerical integration.
Applications of Integration	Mechanics and electricity. Areas. Volumes. Centroids. Moments of inertia.
Differentiation of Transcendentals	Derivatives of the trigonometric and inverse trigonometric functions. Derivatives of the logarithmic and exponential functions.
Methods of Integration	The general power formula. The basic logarithmic and trigonometric forms. The exponential form. Other trigonometric forms. Inverse trigonometric forms. Trigonometric substitution. Integration by the use of tables.
Expansion of Functions in Series	Maclaurin series. Operations with series and computations by use of series expansions. Taylor's series. Fourier series.

TABLE 8 (Continued)

Mathematical Topic Heading	Description
Differential Equations	Solutions of differential equations. Separation of variables. Integrable combinations. Linear differential equation of the first order; and higher order. Second order homogeneous equations with constant coefficients. Auxiliary equations with repeated or complex roots. Solutions of non-homogeneous equations.
Laplace Transforms	Introduction. Table of Laplace transforms. Solving differential equations by Laplace transforms.

Table 9 contains the pre-prepared set of mathematics topics headings for the statistics and computer programming courses.

Some additional mathematics topic headings appear in the tables which were prepared for the different institutes. The reason for this is that those particular topics were not included in the pre-prepared list; to make the list complete, those had to be included in the tables. There was no attempt made to further qualify the meaning of these added topic headings.

TABLE 9

MATHEMATICS TOPIC HEADINGS
STATISTICS AND COMPUTER PROGRAMMING

Mathematical Topic Heading	Description
Probability	Experimental calculation of

TABLE 9 (Continued)

Mathematical Topic Heading	Description
Probability (continued)	probability. Theoretical calculation of probability. Rules for combining probability. Expected value.
Reducing Raw Data to Usable Form	Class limits, frequency, tallying, class boundaries. Graphs. Histograms. Frequency polygons. Cumulative frequency curve.
Frequency distributions	Binomial, Hypergeometric, Poisson and Normal distribution.
Measures of Central Tendency	Mean, median, mode.
Measures of Dispersion	Standard deviation. The range. Methods for computing the standard deviation.
Sampling	Estimation of the average and standard deviation of the population. Reliability estimate. Operating characteristics of sampling schemes.
Curve Fitting	Fitting straight lines to experimental data.
Quality Control	Quality control charts for dimensionally controlled components. Quality control chart for components to be tested on a "good" or "bad" system.
Significance	Significance and probability. The use of 5% level and 2% level.
t-Test	Student's t distribution. The use of tables. One-tail test.
Introduction to Computers	Components of a computer. Organization of a computer system. Basic operation and use of the computer.

TABLE 9 (Continued)

Mathematical Topic Heading	Description
Coding Methods	The nature of computer instructions. Flow charts. Languages.
Components.	Highlights of the Fortran language, input and output, decisions, commands.
Fortran IF	Constants, variables, arithmetic operations, functions, assignment statements, labels, input-output, declarations, arithmetic IF, logical IF.
Do Loops	Subscripted variables. Declarations, iterations, nested iterations. Input-output. Functions.
Sub-Programs	Subroutines. Equivalence, Common, Data, efficient programming.
Application of Programming	Solving problems related to the particular technology.

Mathematics Topic Headings for the Institutes

The following tables summarize the courses offered at each of the six institutes of technology. In every case the pre-prepared list of topic headings is used. In some cases additional headings appear which are due to the previously discussed reasons.

In some cases the course descriptions were not detailed enough, or the courses were specialty courses and, therefore, did not lend themselves to the topic heading breakdown. In these cases the course descriptions precede the topic heading tables

Table 10 and Table 11 were prepared for RRCC; and Table 12 and Table 13 were prepared for SIAAS.

Table 10 and Table 11 contain all mathematics courses offered to the engineering technologies except the following courses:

> Math - 403 Mathematics
> Fortran programming with emphasis on applications in the Electrical Technology area. Selected topics on Advanced calculus. Introduction to and use of statistics, and other selected topics.
>
> Math - 310 Mathematics
> The oblique triangle, computational methods and accuracy. Basic geometrical properties of parallel lines, triangles, circles and spheres. Spherical triangles, right angled, oblique types, sine law, cosine laws, Napier's analogies. Latitude and Longitude as spherical co-ordinates. Area of the spherical triangle.

Table 12 and Table 13 contain all mathematics courses offered to the engineering technologies except the following two courses:

> CP 3084
> This study involves the basic principles of analog and digital computations. Fortran programming, solution of selected problems in statistics, and in applied calculus.
>
> CS 4072
> A comprehensive study of the techniques of Fortran IV programming and its application to engineering problems.

TABLE 10

MATHEMATICS TOPIC HEADINGS
RRCC

	Math 102	Math 104	Math 106	Math 107	Math 109	Math 204
Slide Rule		X	X			X
Fundamental Concepts and Operations	X	X	X			X
Functions and Graphs	X	X	X			X
The Trigonometric Functions	X	X	X		X	X
Systems of Linear Equations; Determinants	X	X	X	X	X	X
Factoring and Fractions	X	X	X		X	X
Quadratic Equations	X	X	X		X	X
Trigon. Functions of Any Angle. Radians					X	
Vectors and Oblique Triangles				X		
Graphs of the Trigonometric Functions	X	X	X			X
Exponents and Radicals	X	X	X		X	X
The J-operator	X					
Logarithms	X	X	X	X	X	X
Equations of Higher Degree				X		
Determinants and Matrices				X		
Inequalities						
Variation						
Progressions						
Trigonometric Identities. Inverse.	X	X	X	X	X	X

TABLE 10 (Continued)

	Math 102	Math 104	Math 106	Math 107	Math 109	Math 204
Straight Line	X	X	X	X	X	X
The Circle	X	X	X	X	X	X
Plane Analytic Geometry				X		
Statistics: Error, Confidence				X	X	

TABLE 11

MATHEMATICS TOPIC HEADINGS
RRCC

	Math 202	Math 206	Math 207	Math 209	Math 302	Math 303	Math 305	Math 306	Math 307	Math 309	Math 312	Math 402
Algebra		X										
Algebraic Equations		X										
Trigonometric Equations		X										
Curve Plotting		X										
Logarithms		X										
3-d Geometry				X								
The Derivative	X	X	X	X				X			X	
Applications of the Derivative	X		X					X			X	
Integration	X	X	X	X								
Application of Integration			X				X	X		X	X	
Differentiation of Transcendentals	X		X									
Methods of Integration			X							X		
Expansion of Functions in Series					X	X	X		X			
Differential Equations					X	X	X		X	X	X	
Computer Programming IF, DO.				X			X	X	X		X	X
Subroutines.												
Numerical Methods. Computer					X	X	X					

TABLE 11 (Continued)

	Math 202	Math 206	Math 207	Math 209	Math 302	Math 303	Math 305	Math 306	Math 307	Math 309	Math 312	Math 402
Introduction to Desk Top Computers			X					X				
Statistics: probability, distributions										X		X
Partial Differentiation									X	X	X	X
Multiple Integration										X		

TABLE 12

MATHEMATICS TOPIC HEADINGS
SIAAS

	MA 1224	MA 2234	MA 2233	MA 3234
Slide Rule				
Fundamental Concepts and Operations				
Functions and Graphs	X			
The Trigonometric Functions	X			
Systems of Linear Equations; Determinants	X			
Factoring and Fractions	X			
Quadratic Equations	X			
Trig. Functions of Any Angle. Radians	X			
Vectors and Oblique Triangle	X			
Graphs of the Trigonometric Functions				
Exponents and Radicals	X			
The J-operator				
Logarithms				
Equations of Higher Degree				
Determinants and Matrices				
Inequalities	X			
Variation				
Progressions				

TABLE 12 (Continued)

	MA 1224	MA 2234	MA 2233	MA 3234
Trigonometric Identities Inverse				
Straight Line	X			
The Circle	X			
Plane Analytic Geometry	X			
Statistics; Error, Confidence				
The Derivative	X	X	X	X
Applications of the Derivative	X	X	X	X
Integration		X	X	X
Applications of Integration		X	X	X
Differentiation of Transcendentals		X	X	X
Methods of Integration		X	X	X
Expansion of Functions in Series				
Differential Equations		X	X	X
Laplace Transforms				
Partial Derivatives				
Multiple Integrals				

TABLE 13

MATHEMATICS TOPIC HEADINGS
SIAAS

	MA 2523	MA 3523	MA 4533
Probability	X	X	
Reducing Raw Data to Usable Form	X	X	
Frequency Distributions	X	X	
Measures of Central Tendency	X	X	
Measures of Dispersion	X	X	
Sampling			
Curve Fitting			
Quality Control	X	X	
Significance	X	X	
Correlation and Regression			X
Randomized Design. Analysis of Variance			X
Randomized Block Design			X
Factorial Design			X
Time Series Analysis			X
Confidence Intervals	X	X	
Computer Programming			

In some cases the entry in the tables is a "?" instead of an "X". The reason for this is that in the calendar description there is only some indication regarding that particular topic, and the reference to the topic is implicit rather than explicit.

Table 14 and Table 15 contain all courses, offered at STI, except the following nine courses listed below:

M20.42 Statistics
Frequency distribution, averages, measures of variation, probability, normal curve, estimation.

M30.42 Statistics
Practical engineering statistics. Errors, probability, distributions, samples, averages, dispersion, normal distribution, simple correlation and regression.

CP30.42 Computer Programming
Applications of the IBM 1130 computer in the solutions of problems in Civil Technology. Emphasis on basic Fortran.

CP40.32 Computers and Programming
An introductory course in computer fundamentals, programming and problem solving. The purpose is to acquaint the students with computer applications in process control.

BP50.11 Basic Programming
Introduction to the BASIC computer language. Programming techniques are illustrated through applications.

DG60.13 Descriptive Geometry
Three dimensional objects on two-dimensional media. Engineering problems.

DG60.23 Descriptive Geometry
Continuation of DG60.13

M64.34 - Part A - Spherical Trigonometry
Spherical triangles, right and oblique. Terrestrial and astronomical triangles.

M62.43 Graphical Mathematics
Tabulation of data, co-ordinate line charts, trilinear charts, nomograms.

TABLE 14

MATHEMATICS TOPIC HEADINGS
STI

	M20.14	M60.14	M30.14	M40.16	M50.16	M60.23
Slide Rule	X	X	X		X	
Fundamental Concepts and Operations	?	?	?			
Functions and Graphs	X	X	?			
The Trigonometric Functions	X	X	X	X		
Systems of Linear Equations: Determinants			X	X		
Factoring and Fractions			?	X		
Trigon. Functions of Any Angle. Radians	?	?	X	X		
Vectors and Oblique Triangles	?	?	?	?	X	
Graphs of the Trigonometric Functions	?	?	?	?		
Exponents and Radicals				?		
The J-operator				X	X	
Logarithms			X		?	
Equations of Higher Degree	?	?		X		
Determinants and Matrices						
Inequalities						
Variation						
Progressions						
Trigonometric Identities. Inverse.						

TABLE 14 (Continued)

	M20.14	M60.14	M30.14	M40.16	M50.16	M60.23
Straight Line						
The Circle						
Plane Analytic Geometry						X
Statistics - Error, Confidence				X		X
The Derivative	X	X		X		
Applications of the Derivative						
Integration	X	X		X		
Graphical Mathematics					X	
Lines, Planes and Surfaces in Space						X
Quadratic Equations			X			X

TABLE 15

MATHEMATICS TOPIC HEADINGS
STI

	M20.24	M20.33	M20.42	M30.24	M30.33	M40.24	M40.32	M50.25	M50.32	M62.33	M64.44
Plane Analytic Geometry	X			X		X		X			
The Derivative	X			X		X		X		X	X
Applications of the Derivative	X			X		X	X				X
Integration	X			X		X		X		X	X
Applications of Integration	X	X			X	X	X	X			X
Differentiation of Transcendentals					X	X					
Methods of Integration					X						
Expansion of Functions In Series							X		X		
Differential Equations					X		X		X		
Laplace Transforms									X		
Numerical and Geometrical Interpretation			X								
Bessel's Functions									X		
Partial Derivatives							X				

Table 16, Table 17, Table 18 and Table 19 contain all mathematics courses offered to the engineering technologies at NAIT except the following two courses:

ASM 251. Geometry
Lines and angles; triangles; parallelograms; trapezoids; properties of circles; segments and sectors of circles; areas; solid figures.

ASM 452. Spherical Trigonometry
Solid geometry; spherical triangles; polar triangles; Napier's rules; laws of quadrants; solutions of spherical triangles.

TABLE 16

MATHEMATICS TOPIC HEADINGS
NAIT

	ASM 100	ASM 103	ASM 104	ASM 105	ASM 107	ASM 109	ASM 111	ASM 112	ASM 115	ASM 117	ASM 119	ASM 121	ASM 122	ASM 123	ASM 125	ASM 127	ASM 426	ET 100
Slide Rule	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X
Fundamental Concepts and Operations										X	X			X			X	
Functions and Graphs		X		X		X					X							X
The Trigonometric Functions	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X
Systems of Linear Equations; Determinants			X	X										X			X	
Factoring and Fractions			X							X				X				
Quadratic Equations		X		X		X				X				X				
Trigon. Functions of Any Angle. Radians	X	X		X	X	X		X	X	X	X	X	X	X	X	X		X
Vectors and Oblique Triangles	X	X		X	X	X	X	X	X	X		X	X	X	X	X		X
Graphs of the Trigonometric Functions		X				X				X								X

TABLE 16 (Continued)

	ASM 100	ASM 103	ASM 104	ASM 105	ASM 107	ASM 109	ASM 111	ASM 112	ASM 115	ASM 117	ASM 119	ASM 121	ASM 122	ASM 123	ASM 125	ASM 127	ASM 426	ET 100
Exponents and Radicals		X	X	X	X					X				X			X	X
The J-operator							X	X					X			X		
Logarithms		X	X	X			X			X			X	X		X		X
Equations of Higher Degree			X				X											
Determinants and Matrices			X										X				X	X
Inequalities																	X	
Variation				X														
Progressions												X						
Trigonometric Identities Inverse															X			
Straight Line																		
The Circle																		
Plane Analytic Geometry							X					X				X		
Statistics: Error, Confidence			X															
Vectors in Three Dimensions								X										
The Derivative							X											

TABLE 17

MATHEMATICS TOPIC HEADINGS
NAIT

	ASM 201	ASM 208	ASM 210	ASM 2216	ASM 218	ASM 220	ASM 264	ASM 302
Slide Rule								
Fundamental Concepts and Operations	X							
Functions and Graphs								X
The Trigonometric Functions								
Systems of Linear Equations; Determinants			X		X	X		X
Factoring and Fractions								X
Quadratic Equations		X				X		X
Trigon. Functions of Any Angle. Radians								
Vectors and Oblique Triangles				X		X		
Graphs of the Trigonometric Functions						X		
Exponents and Radicals	X			X				
The J-operator								
Logarithms	X	X	X	X				
Equations of Higher Degree		X			X		X	X
Determinants and Matrices								
Inequalities		X			X		X	
Variation			X		X		X	
Progressions					X		X	

TABLE 17 (Continued)

	ASM 201	ASM 208	ASM 210	ASM 2216	ASM 218	ASM 220	ASM 264	ASM 302
Straight Line								
The Circle								
Plane Analytic Geometry		X	X				X	X
Statistics: Error, Confidence							X	
Areas, angle sums, constructions			X					

TABLE 18

MATHEMATICS TOPIC HEADINGS
NAIT

	ET 200	ASM 230	ASM 231	ASM 232	ASM 233	ASM 234	ASM 236	ET 300	ASM 332	ASM 334	ASM 341	ASM 342	ASM 343	ASM 344	ASM 430	ASM 537	ASM 640
Systems of Linear Equations. Determinants				X													
Logarithms			X														
Equations of Higher Degree																	
Determinants and Matrices			X				X										
Inequalities																	
Variation																	
Progressions																	

TABLE 18 (Continued)

	ET 200	ASM 230	ASM 231	ASM 232	ASM 233	ASM 234	ASM 236	ET 300	ASM 332	ASM 334	ASM 341	ASM 342	ASM 343	ASM 344	ASM 430	ASM 537	ASM 640
Trigonometric Identities. Inverse																	
Plane Analytic Geometry	X		X	X		X										X	
The Derivative	X	X	X	X	X	X	X		X	X					X	X	
Applications of the Derivative	X	X			X	X	X		X	X	X				X	X	
Integration	X	X		X	X				X	X	X		X	X	X		X
Applications of Integration	X	X			X				X	X	X		X	X	X		X
Differentiation of Transcendentals	X	X		X	X	X	X		X	X	X				X		X
Methods of Integration		X						X	X	X	X	X	X	X			X
Expansion of Functions in Series		X						X				X	X	X			
Differential Equations		X						X				X	X	X			
Laplace Transforms								X									
Partial Derivatives								X									
Multiple Integrals								X									

TABLE 19

MATHEMATICS TOPIC HEADINGS
NAIT

	FT 252	ASM 270	ASM 372	ASM 367	ASM 380	ASM 390	ASM 460	ASM 461	ASM 462	ASM 463	ASM 470	ASM 471	ASM 476	ASM 481	ASM 560	ASM 591	ASM 571	ASM 580	ASM 662	ASM 680	ASM 681	ASM 699
Probability	X			X			X	X	X	X			X		X				X			
Reducing Raw Data to Usable Form	X						X	X	X	X					X				X			
Frequency Distributions	X						X	X	X	X					X				X			
Measures of Central Tendency	X			X			X	X	X	X			X		X				X			
Measures of Dispersion	X						X	X	X	X					X				X			
Sampling	X			X			X	X	X	X			X		X				X			
Curve Fitting	X						X	X	X	X					X				X			
Quality Control	X						X	X	X	X					X				X			
Significance	X			X			X	X	X	X			X		X				X			
t-Test	X																					
Introduction to Computers		X	X	X	X						X	X	X	X			X	X		X		
Coding Methods		X	X	X	X						X	X	X	X			X	X		X		
Components		X	X	X	X						X	X	X	X			X	X		X		
Fortran IF		X	X	X	X						X	X	X	X			X	X		X		
Do-Loops					X	X								X		X				X		
Sub-Programs						X										X					X	
Applications of Programming						X										X					X	
Truth Tables																					X	

TABLE 19 (Continued)

	FT 252	ASM 270	ASM 372	ASM 367	ASM 380	ASM 390	ASM 460	ASM 461	ASM 462	ASM 463	ASM 470	ASM 471	ASM 476	ASM 481	ASM 560	ASM 591	ASM 571	ASM 580	ASM 662	ASM 680	ASM 681	ASM 699
Numerical Integration																						X
Vectors and Matrices																						X
Introduction to Desk Top Computers																					X	

Tables 20, 21, 22, 23 and 24 contain all mathematics courses offered at SAIT to the engineering technologies except the following course:

GEOM-001
Angles; parallel lines; triangles; polygons; circles; rectilinear figures; solids; similar figures; irregular figures; analytic geometry.

TABLE 20

MATHEMATICS TOPIC HEADINGS
SAIT

	TRIG 001	TRIG 002	TRIG 003	MATH 115
Slide Rule				
Fundamental Concepts and Operations				
Functions and Graphs				
The Trigonometric Functions	X			
Systems of Linear Equations; Determinants				
Factoring and Fractions		X		X
Quadratic Equations				
Trig. Functions of Any Angle. Radians	X	X		X
Vectors and Oblique Triangle	X			
Graphs of the Trigonometric Functions	X			
Exponents and Radicals				
The J-operator		X		X
Logarithms		X		X
Equations of Higher Degree				
Determinants and Matrices				
Inequalities				
Variation				
Progressions				
Trigonometric Identities. Inverse	X			X
Wrapping Functions		X		X

TABLE 20 (Continued)

	TRIG 001	TRIG 002	TRIG 003	MATH 115
Hyperbolic Functions		X		X
Geometry of a Sphere			X	
The Right Spherical Triangle			X	
The Oblique Spherical Triangle			X	

TABLE 21

MATHEMATICS TOPIC HEADINGS
SAIT

	CALC 001	CALC 002	CALC 003	CALC 004	GEOM 002	MATH 125
Relations and Functions	X					
Sequences and Series	X					
The Derivative	X	X			X	X
Applications of the Derivative	X	X				X
Integration	X		X			X
Applications of Integration	X		X			
Conic Sections		X			X	
Differentiation of Transcendental Functions		X				X
Methods of Integration			X			
Expansion of Functions in Series			X	X		
Differential Equations				X		

TABLE 22

MATHEMATICS TOPIC HEADINGS
SAIT

	CT-100	CT-200	CT-206	CT-207	CT-208	CT-211	CT-217
Introduction to Computer Systems	X	X				X	
Coding Methods	X	X				X	
Input and Output Devices	X	X				X	
Fortran, IF, DO.	X	X				X	
Functions	X	X					
Subroutines							
Boolean Algebra							
OR, AND, NAND, NOR Gates			X				
Conversion of Digital and Anolog Values			X				
Signal Conditioning			X				
Process Control			X				X
Generation of Closed Loop Processes			X				
Data Processing Equipment				X			
Present and Future Techniques				X			
Time Sharing Terminals					X		
BASIC Programming					X		
Advanced Fortran Programming					X		X

TABLE 22 (Continued)

	CT-100	CT-200	CT-206	CT-207	CT-208	CT-211	CT-217
COGO						X	
General Concepts						X	
Vocabulary Commands						X	
Plotting						X	
Real Time System							X
Process Optimization							X
Projects			X				X

TABLE 23

MATHEMATICS TOPIC HEADINGS
SAIT

	ALG-001	ALG-002	MATH-145	STAT-001	MATH-980
Functions and Graphs	X				
Systems of Linear Equations	X				
Factoring	X				
Solving Quadratic Expressions	X				
Exponents and Radicals	X				
Sets; Set Algebra; Real number system		X			
Relations and Functions		X			
Matrices and Determinants		X			

TABLE 23 (Continued)

	ALG-001	ALG-002	MATH-145	STAT-001	MATH-980
Complex Numbers		X			
Sequences, Series, Limits		X			
Theory of Equations		X			
Probability		X			
Arithmetical and Algebraic Equations			X		
Trigonometric Functions			X		
Logarithmic and Exponential Functions			X		
Graphical Techniques			X		
Reducing Raw Data to Usable Form				X	X
Frequency Distributions				X	X
Measures of Central Tendency				X	X
Measures of Dispersion				X	X
Probability				X	X
Distributions				X	X
Sampling				X	X
Quality Control					X
Tests of Significance					X

TABLE 24

MATHEMATICS TOPIC HEADINGS
SAIT

	ADVC-001	ADVC-002	ADVC-003
Vectors in the Plane	X		
Indeterminate Forms	X		
Improper Integrals	X		
Infinite Series	X		
Expansion of Functions	X		
Hyperbolic Functions	X		
Partial Differentiation	X		
Multiple Integrals	X		
Vectors in Three Dimensions		X	
Lines and Planes		X	
Vector Calculus		X	
Linear Algebra. Matrices		X	
Determinants. Laplace Transforms		X	
Matrix solutions			X
Computer solutions			X
Vector Field Theory in Fluid Mechanics			X
Mechanical Vibrations			X
Response of systems			X
Fourier analysis			X

At BCIT the mathematics courses are organized in six units. In the course number the last two digits refer to these units.

All courses except the following mathematics courses are included in Table 25.

32.170 Basic Mathematics (Electrical)

Linear equations, matrices, and determinants, with applications to mesh circuit analysis. Logarithmic and exponential functions, with applications to transient and power problems. Trigonometry, with emphasis on wave-forms, vectors, and use of identities. Complex numbers and their use in a.c. circuit calculations.

37.270 Calculus (Electrical)

A course in calculus dealing with the following topics with applications throughout in the electrical and electronics fields. The differentiation and integration of algebraic, trigonometric, logarithmic, exponential, and hyperbolic functions; partial differentiation; infinite series; differential equations. Elementary numerical methods and computing techniques.

32.370 Transform Calculus (Electrical)

Laplace transforms; transform pairs of functions and operations, inverse transforms, applications to circuits involving integro-differential equations, the transfer function, pole-zero configurations. Multimesh analysis in the s-domain

14.351 Computer Applications

Applications of the computer in engineering and appliccations of medical technologies; how a computer works, recognizing problems suitable for computer solution, flow-charting and communicating with computer personnel; emphasis is on the use of computers to solve problems related to the technology concerned. Where available, "package" programmes will be demonstrated and used by students.

14.408 Linear Programming

Graphical method; algebraic method; simplex method; analysis of simplex results; LP problem formulation; use of computers to solve problems; analysis of computer solution; use of reduced costs and shadow prices; sensitivity analysis; practical applications and limitations of LP; implementation of results.

TABLE 25

MATHEMATICS TOPIC HEADINGS
BCIT

Unit		32.101	32.223	32.226	32.246	32.302	32.304	32.306	32.406	32.436	32.454	32.456
	Algebra	X										
1	Trigonometry	X										
	Analytic Geometry	X										
	The Derivative		X	X		X						
	Applications of the Derivative		X	X		X						
2	Integration		X	X		X						
	Application of Integration		X	X		X						
	Differentiation of Transcendentals		X	X		X						
	Methods of Integration		X	X		X						
	Expansion of Functions in Series		X							X		
3	Differential Equations		X							X		
	Partial Derivatives		X							X		

TABLE 25 (Continued)

Unit		32.101	32.223	32.226	32.246	32.302	32.304	32.306	32.406	32.436	32.454	32.456
	Reducing Raw Data to Usable Form				X		X				X	
	Frequency Distributions				X		X				X	
	Measures of Central Tendency				X		X				X	
4	Measures of Dispersion				X		X				X	
	Sampling				X		X				X	
	Estimation				X		X				X	
	Hypothesis Testing				X		X				X	
	Regression				X		X				X	
	Iterative Methods										X	X
	Finite Differences										X	X
5	Numerical Integration, Differentiation										X	X
	Numerical Solutions of Differential Equations										X	X
6	Further applied mathematics topics of importance within one of the categories; Calculus III, Statistics II, Analytic Geometry, Spherical Trigonometry, Numerical Methods II.			X	X			X	X	X		X

Table 27 lists the engineering technologies and the institutes. The entries in this table are the mathematics entrance requirements. The first five letters of the alphabet are used to represent the five different groups of admission requirements. The categories represented by each letter are stated in Table 26.

TABLE 26

ADMISSION REQUIREMENT CATEGORIES

Admission Requirement Code	Description
A	Manitoba: RRCC. Mathematics 301 or 300 Saskatchewan: STI and SIAAS. Grade XII Algebra, Geometry, Trigonometry Alberta: NAIT. Mathematics 30, 32, 33 or 36 50% or better. SAIT. Mathematics 30 or 36 Applicants with Math 32 or 33 must register for Mathematics pre-quarter session. British Columbia: BCIT. Mathematics 12
B	Alberta: SAIT. Mathematics 30, 36 or 50% standing in Mathematics 32 or 33
C	Alberta: SAIT. Mathematics 20, 22 or 23, 50% standing.
D	Alberta: SAIT. Mathematics 20, 22 or 23, 40% standing.
E	Alberta: NAIT. Mathematics 30, 32, 33 or 36, 40% or better.

TABLE 26 (Continued)

Admission Requirement Code	Description
All	Pre-Technology. In case of successful completion of pretechnology courses student may enter any of the technologies.
All	Mature student. In case of successful completion of assigned program student may enter any of the technologies.

TABLE 27

THE ENGINEERING TECHNOLOGIES, THE INSTITUTES OF TECHNOLOGY AND THE ENTRANCE REQUIREMENTS.

Technology	RRCC	STI	SIAAS	SAIT	NAIT	BCIT
Aeronautical Engineering				A		
Air Conditioning Engineering				B		
Air Conditioning and Refrigeration					E	
Architectural		A			A	
Bio-chemical	A					
Building	A					A
Building Construction					E	
Chemical	A			A	E	
Chemical Engineering				A		
Chemical Research					E	
Civil	A	A			A	
Civil and Structural						A

TABLE 27 (Continued)

Technology	RRCC	STI	SIAAS	SAIT	NAIT	BCIT
Design and Drafting	A					
Drafting		A			A	
Earth Resources, Coal					A	
Earth Resources, Petroleum					A	
Environmental Services						A
Electrical	A	A			A	A
Electrical Engineering				B		
Electronics	A	A			A	A
Electronics Engineering-Communications				A		
Electronics Engineering-Industrial				B		
Electronics Engineering				A		
Extractive Metallurgy						A
Engineering Graphics				B		
Environmental - Architectural				A		
Environmental - Building Development				A		
Forest					E	
Forestry						A
Forestry - Fish and Game						A
Forest Resource - Wood						A
Forest Resource - Pulp and Paper						A
Gas					E	
Heat and Power	A					

TABLE 27 (Continued)

Technology	RRCC	STI	SIAAS	SAIT	NAIT	BCIT
Industrial Engineering				D		
Industrial Chemistry						A
Industrial Chemical			A			
Industrial Production					A	
Instrumentation	A				A	
Instrumentation and Systems						A
Materials Testing and Metallurgy					E	
Mechanical			A			
Mechanical Engineering				A		
Mechanical Production						A
Mechanical Design						A
Metallurgical						A
Mining						A
Natural Gas and Petroleum						A
Petroleum - Production				A		
Petroleum - Geology				A		
Petroleum - Reservoir				A		
Physical Metallurgy						A
Plastics					E	
Pollution Treatment						A
Power Engineering				A		
Production	A					
Renewable Resources			A			

TABLE 27 (Continued)

Technology	RRCC	STI	SIAAS	SAIT	NAIT	BCIT
Structural	A					
Structural Engineering				B		
Surveying	A	A		A	A	A
Surveying - Photogrammetry						A
Telecommunications					A	
Water Sciences			A			
Pre-Technology	ALL				ALL	
Mature Student Program	ALL	ALL	ALL		ALL	

The total number of instructional days was computed for each institute on the basis of the 1971-72 calendar events. The total number of instructional days and the equivalent number of weeks are given in Table 28 for only those institutes which are operating on the semester system.

TABLE 28

THE TOTAL NUMBER OF INSTRUCTIONAL DAYS
AND THE EQUIVALENT NUMBER OF WEEKS

Institute of Technology	First and Third Terms		Second and Fourth Terms	
	Days	Weeks	Days	Weeks
RRCC	87	17.4	85	17.0
STI	86	17.2	86	17.2
SIAAS	90	18.0	92	18.4
BCIT	66	13.2	92	18.4

SAIT and NAIT are on the quarter system. Three quarters complete the academic year for the students, each quarter being 12 weeks long.

Table 29 contains the total number of instructional hours for each technology program at the respective institute of technology. Optional courses are not included in the total.

TABLE 29

THE ENGINEERING TECHNOLOGIES AND THE INSTITUTES OF TECHNOLOGY TOTAL NUMBER OF INSTRUCTIONAL HOURS

Technology	RRCC	STI	SIAAS	SAIT	NAIT	BCIT
Aeronautical Engineering				468		
Air Conditioning Engineering				180		
Air Conditioning and Refrigeration					210	
Architectural		241			108	
Bio-chemical	242					
Building	206					158

TABLE 29 (Continued)

Technology	RRCC	STI	SIAAS	SAIT	NAIT	BCIT
Building Construction					120	
Chemical	259			96	48	
Chemical Engineering				272		
Chemical Research					96	
Civil	259	310			192	
Civil and Structural						253
Design and Drafting	308					
Drafting		258			156	
Earth Resources, Coal					288	
Earth Resources, Petroleum					288	
Environmental Services						158
Electrical	361	275			228	376
Electrical Engineering				312		
Electronics *	378	322			0/168	376
Electronics Engineering - Communications *					144/120	
Electronics Engineering - Industrial *					144/120	
Electronics Engineering						
Extractive Metallurgy						316
Engineering Graphics				180		
Environmental - Architectural				144		
Environmental - Building Development				216		
Forest					144	

TABLE 29 (Continued)

Technology	RRCC	STI	SIAAS	SAIT	NAIT	BCIT
Forestry						158
Forestry - Fish and Game						195
Forest Resource - Wood						253
Forest Resource - Pulp and Paper						266
Gas					252	
Heat and Power	242					
Industrial Engineering				276		
Industrial Chemistry						316
Industrial Chemical			271			
Industrial Production					246	
Instrumentation	276				204	
Instrumentation and Systems						200
Materials Testing and Metallurgy					180	
Mechanical			219			
Mechanical Engineering				276		
Mechanical Production						316
Mechanical Design						316
Mining						316
Natural Gas and Petroleum						342
Petroleum - Production				264		
Petroleum - Geology				264		

TABLE 29 (Continued)

Technology	RRCC	STI	SIAAS	SAIT	NAIT	BCIT
Petroleum - Reservoir				264		
Physical Metallurgy						316
Plastics					180	
Pollution Treatment						316
Power Engineering				264		
Production	293					
Structural	206					353
Structural Engineering				180		
Surveying	413	464		444	456	342
Surveying - Photogrammetry						342
Telecommunications					180	
Water Sciences			255			

*Mathematics courses are taught to these technologies by the Mathematics Department as well as by the technology. The numerator represents the number of hours taught by the Mathematics Department; the denominator represents the number of hours of mathematics taught by the technology. The number in the denominator is unreliable since in most cases it is impossible to determine the mathematics content; therefore this number might be high or low.

The Available Mathematics Upgrading Courses

The popularity of providing upgrading courses for the prospective students of the technologies is far from being uniform. Only RRCC and NAIT calendars contain reference to regular daytime pre-technology courses. At RRCC the mature student, it would appear, is registered in the regular pre-technology program, while at NAIT there are specially designed upgrading programs for the mature student as well as the student straight from high school but with deficiency in mathematics. NAIT has three pre-technology programs. These are as follows:

Program A. The NAIT Calendar (1972-73) states that this course "... is designed for the student who has had only marginal success in Math, Sciences, and English (p. 263)."

Program B. The NAIT Calendar (1972-73) describes the program as follows: "Program B is intended for the student who has a reasonable academic background but still lacks most of the Year 1 entrance requirements (p. 263)."

Program C. The NAIT Calendar (1972-73) states that this course "... is designed for the student who requires the equivalent of one or two specific Grade 12 subjects for Year 1 entrance (p. 263)."

In the SAIT Calendar (1972-73) the following statement may be found regarding pre-technology programs and adult students:

> For general admission to S.A.I.T. an applicant must have an Alberta High School Diploma or the equivalent or be 18 years of age if he does not have such a diploma (p. 255).
>
> An applicant who has general admission but does not have the specific subject prerequisities for the program of his choice may register in one or more of Mathematics, Physics and English at S.A.I.T. Instruction in each subject will end when the student has reached the level of competence required for entry into the program.

The Head of the Mathematics Section of SAIT states in his answer to the questionnaire that there is "an individualized pre-technology program with entrance each September, January and April." Further he states that " a special 6 week program in August 15 - September for students with Math 32 or Math 33" is offered by the Mathematics Department.

At RRCC, a mature student is considered to be one who is at least 20 years of age, while in Saskatchewan the minimum age is 21. In Alberta, SAIT sets the minimum age at 18 years of age, while NAIT sets it at 21 years of age. There is no statement found in the BCIT calendar regarding mature student status. The age limit is set at 16 and that includes all prospective students.

The above stated programs and the mature status of a student create additional avenues for admission to NAIT, SAIT, RRCC, STI and SIAAS. In the case of BCIT there are no additional avenues open for the prospective student; he must be 16 years of age and must satisfy the entrance requirements as stated in the BCIT Calendar.

<u>Tne Differences Between the Mathematics Courses Offered to the same Technologies at Different Institutes</u>.

In some cases the identical name, for example Survey Technology, is used at each Institute of Technology to refer to the particular technology. In other cases, the relationship is not as explicit; for example, Design and Drafting at RRCC, Drafting at STI and NAIT, and Engineering Graphics at SAIT, are designations that presumably refer to related areas of endeavour.

The following pages contain a grouping of the technologies. The differences between the mathematics courses within each group are considered. In parentheses the total number of mathematics instructional hours is given.

1. Air Conditioning Engineering SAIT (180)

   Air Conditioning and Refrigeration NAIT (210)

The emphasis at NAIT is on basic algebra and trigonometry. The SAIT courses include topics such as complex numbers, probability, wrapping functions, hyperbolic functions, and introductory calculus. The computer courses are also different. At SAIT the students get no exposure to statistics, while at NAIT they do.

Summary of Analysis: The mathematics course contents are different.

2. Architectural STI (241), NAIT (108)

   Environmental - Architectural SAIT (144)

Of the three institutes NAIT offers the least number of topics in mathematics. Both SAIT and STI offer an introductory calculus course. SAIT's calculus course covers differentiation only , while STI's calculus course includes applications of the derivative, integration and application of integration. Again, of the three institutes only NAIT offers introductory Fortran and application of programming.

Summary of Analysis: The mathematics course contents are very different.

3.	Bio-Chemical	RRCC (242)
	Chemical	RRCC (259)
	Chemical Engineering	SAIT (272)
	Industrial Chemistry	BCIT (316)
	Industrial Chemical	SIAAS (271)
	Pollution Treatment	BCIT (316)

These six technologies are almost identical in the mathematical topics which they cover.

Summary of Analysis: No major differences.

4.	Chemical	SAIT (96)
	Chemical	NAIT (48)
	Chemical Research	NAIT (96)

The NAIT Chemical Technology falls short in calculus as well as in trigonometry. In comparison to the SAIT technology the NAIT Chemical Research Technology is short of trigonometry.

Summary of Analysis: All three are different.

5.	Building	RRCC (206), BCIT (158),
	Building Construction	NAIT (120)
	Environmental - Building	SAIT (216)
	Environmental - Services	BCIT (158)

The Building Construction technology at NAIT is the only one in which no calculus is offered. Only RRCC and SAIT offer computer programming, the others do not.

Summary of Analysis: Building and Environmental Services at BCIT are identical. RRCC and BCIT are similar except for computer programming. In comparison to RRCC and BCIT, SAIT falls short in calculus topics. SAIT offers more instruction in computer programming than any of the others.

6.	Civil	RRCC (259), STI (310), NAIT (192)
	Structural	RRCC (206)
	Structural Engineering	SAIT (180)

There are no major differences in calculus content. The RRCC Civil Technology advances further in mathematics topics than any other technology in this group. STI, BCIT and SAIT cover the same topics in calculus; NAIT's Civil Technology does not include differential equations and expansions of functions in series into the set of topics; otherwise, it is comparable. Only BCIT provides no instruction in introductory computer programming while SAIT advances the furthest in this topic. No instruction is provided in

statistics at STI and SAIT.

Summary of Analysis: In basic mathematics and basic calculus there are no major differences. In advanced calculus there are differences. There are no major differences in the statistics and introductory computer programming courses where these courses are offered. Advanced programming is offered only at SAIT.

7.	Design and Drafting	RRCC (308)
	Drafting	STI (258), NAIT (156)
	Engineering Graphics	SAIT (180)

There is no major difference in the basic mathematics course content between the offerings. There is no difference between the RRCC and STI calculus courses; at SAIT in calculus the instruction carries on into slightly more advanced topics than at the other two institutes. Only STI does not offer programming. Nomography is offered only at STI and geometry only at SAIT. At NAIT there is no calculus course offered.

Summary of Analysis: There is no major difference in the basic mathematics course offerings. There is no significant difference between RRCC and STI calculus courses. Programming courses are no different where offered. There are differences in special course offerings such as nomography and geometry.

8.	Earth Resources - Coal	NAIT (288)
	Earth Resources - Petroleum	NAIT (288)
	Natural Gas and Petroleum	BCIT (342)

Petroleum Production	SAIT (264)
Petroleum Geology	SAIT (264)
Petroleum Reservoir	SAIT (264)
Mining	BCIT (316)
Gas	NAIT (252)

There are no major differences in trigonometry, basic calculus, basic programming and in statistics. NAIT falls short in advanced topics such as expansion of functions in series and differential equations. Only NAIT and SAIT offer advanced programming to these technologies.

Summary of Analysis: There are no major differences in the basic courses. Differences occur only in advanced topics of calculus and in advanced programming.

9.	Electrical	RRCC (361), STI (275), NAIT (228), BCIT (376).
	Electrical Engineering	SAIT (312)

There is no major difference in trigonometry, calculus, and advanced calculus topics except that SAIT does not cover differential equations. RRCC, STI, NAIT offer instruction in statistics while BCIT and SAIT do not. Only STI and BCIT offer no instruction in introductory and advanced programming.

Summary of Analysis: There are no major differences in trigonometry, calculus and, with the exception of one topic, in advanced calculus. Some institutes do not offer statistics and computer programming which fact creates

the differences.

10.	Electronics	RRCC (378), STI (322), NAIT $\left(\frac{0}{168}\right)$, BCIT (376)
	Electronics Engineering - Communication	SAIT $\left(\frac{144}{120}\right)$
	Electronics Engineering - Industrial	SAIT $\left(\frac{144}{120}\right)$
	Telecommunications	NAIT (180)

It is difficult to determine the mathematics content especially in the case of SAIT. Students in Electronics Technology receive instruction up to and including Laplace transforms except at STI, RRCC and in NAIT Telecommunication Technology. RRCC and STI offer computer programming while the others may offer a similar course under the name of technology courses.

Summary of Analysis: There are no major differences in trigonometry, basic calculus and in advanced calculus except Laplace transforms. Regarding computer programming the research is inconclusive.

11.	Extractive Metallurgy	BCIT (316)
	Materials Testing and Metallurgy	NAIT (180)
	Plastics	NAIT (180)
	Physical Metallurgy (Metallurgical)	BCIT (316)

The two Metallurgy technologies of BCIT list identical mathematics courses in their programs. The two NAIT technologies classified into this group are identical

regarding the mathematics course descriptions. The NAIT offerings stop before expansion of functions in series, and the topic of differential equations is also missing from the curriculum. At BCIT a formal statistics course is offered to these technologies while at NAIT there is no formal statistics course offered. There is only an introductory chapter in the regular basic mathematics course.

Summary of Analysis: There are no major differences in trigonometry and basic calculus. There are major differences in the advanced topics of calculus and also in statistics.

12.	Forest	NAIT (144)
	Forestry	BCIT (158)
	Forestry, Fish and Game	BCIT (195)
	Forestry, Wood	BCIT (253)
	Forestry, Pulp and Paper	BCIT (266)

All of the technologies provide a basic and similar trigonometry and an introductory statistics course. From here on, however, differences occur. Only NAIT, BCIT Forestry, Fish and Game, and BCIT Forestry Wood option offer introductory computer programming. Only the BCIT Forestry Wood option offers advanced programming. Only the BCIT Pulp and Paper option offers calculus and advanced calculus courses. Only the Pulp and Paper Technology offers advanced statistics.

Summary of Analysis: Beyond basic trigonometry and statistics, the mathematics courses are different.

13. Heat and Power — RRCC (242)

Power Engineering — SAIT (264)

The offerings are similar regarding trigonometry, basic calculus and introductory programming. At SAIT some advanced calculus topics are offered and also advanced programming.

Summary of Analysis: Beyond basic trigonometry, basic calculus and introductory programming, the courses are different.

14. Industrial Engineering — SAIT (276)

Industrial Production — NAIT (246)

Mechanical Production — BCIT (316)

Production — RRCC (293)

Mechanical — SIAAS (219)

Mechanical Engineering — SAIT (276)

Mechanical Design — BCIT (316)

Offerings are similar with respect to trigonometry, basic calculus and advanced topics in calculus except in the case of SAIT and SIAAS. Industrial Engineering at SAIT and Mechanical at SIAAS do not include expansion of functions in series. Neither Industrial Engineering nor Mechanical Engineering at SAIT includes the topic of differential equations. BCIT is the only institute which offers no computer programming and SIAAS is the only institute which offers no statistics.

Summary of Analysis: Differences occur in the advanced calculus topics only. Differences also occur in course offerings.

15. Instrumentation RRCC (276), NAIT (204)

Instrumentation and Systems BCIT (200)

There are no major differences in trigonometry and in calculus. At RRCC instead of statistics a course in introductory programming is offered.

Summary of Analysis: There are no major differences in the trigonometry and calculus courses. Differences occur in course offerings.

16. Surveying RRCC (413), STI (464), SAIT (444), NAIT (456), BCIT (342)

Surveying, Photogrammetry BCIT (342)

An algebra course is offered at every institute except SAIT. At RRCC the calculus course is only introductory covering the topics of derivative and integration. At STI in calculus the last topic covered is application of integration. At NAIT expansion of functions in series and differential equations are not part of the calculus course. SAIT and BCIT offer a complete calculus course; except that at BCIT, for the Photogrammetry option, the same topics are omitted as for NAIT. There is no geometry course offered at RRCC and BCIT. A descriptive geometry course offered at STI. Programming is not offered only at STI. The NAIT and BCIT offerings are unique in that there

is a course offered in the use of desk top computers at NAIT, and a numerical methods course is in the offering for the photogrammetry option.

Summary of Analysis: In basic courses, such as trigonometry, spherical trigonometry, introductory calculus, there are no major differences. Otherwise the courses are different.

17. The following two technologies do not fit into any of the established groups; therefore, these are left out of the comparison: Aeronautical Engineering SAIT, and Water Sciences SIAAS.

The Number of Instructional Hours in Mathematics

In the previous section the technologies were grouped according to similarity in names and similarity in the courses related to the speciality of that technology. The number of hours of instructions in mathematics was stated in every case. It is extremely difficult to find any relationship between the number of hours of instruction in mathematics and the covered number of topics. In some cases, the relationship is inverse when one makes a comparison within the group; in some cases, it is direct.

Summary of Analysis: There are no general relationships found between number of hours of instruction in mathematics and the covered number of mathematical topics.

Admission Requirements

The admission requirement in mathematics is Grade 12 mathematics for most of the six Western Canadian

Institutes of Technology. In the case of BCIT the prospective student must satisfy this requirement in order to gain admission to the institute.

In Saskatchewan at STI and SIAAS, a student 21 years of age or older may be treated as a mature student. This means that the prospective student is provided with an opportunity to make up for his deficiencies regarding the admission requirements and to gain admission to the institute. Still in Saskatchewan, there is a uniform entrance requirement for all available technologies; this is Grade 12 mathematics.

In Manitoba the admission requirement is Grade 12 mathematics. This institution provides upgrading for the prospective students in order to make up for their deficiencies in mathematics.

In Alberta, both SAIT and NAIT state the admission requirements according to technologies. In the majority of cases, the admission requirement is Grade 12 mathematics. In this province, different levels of mathematics courses are available to the high school students. The calendars of the institutes take this fact into consideration. In some cases the so-called academic mathematics is stated as a requirement; in others, the so-called technical mathematics is acceptable. In some cases 50% or better is required in the stated mathematics course, and in other cases, 40% or better. Some technologies require only Grade 11 mathematics for admission.

Summary of Analysis: A great deal of flexibility is shown regarding entrance requirements in the case of NAIT and SAIT. The other institutes show a high degree of uniformity in this respect: they require Grade 12 mathematics for all technologies.

The Mathematics Upgrading Courses

NAIT provides a well organized pre-technology program for students with deficiency in mathematics. One of these programs is also available during the evening hours.

Only NAIT, SAIT and RRCC have pre-technology programs. SAIT offers an individualized pre-technology program with admission each September, January and April. The individualized pre-technology program at NAIT allows the student to start the program at the beginning of each month except May, June, July and August. No similar details are available in the RRCC calendar.

NAIT has the most highly developed pre-technology program. There is no uniformly developed approach among the Western Canadian Institutes for upgrading the prospective students.

Summary

In this chapter the data was analyzed, tabulated and presented. The list of engineering technologies, the lists of mathematics courses by engineering technologies and the mathematics topics headings were given. The mathematics admission requirements, the total number of

mathematics instructional hours per academic year and information on upgrading courses was presented. The technologies were grouped on the basis of similarity in endeavour, and the differences in mathematics titles and content, the total number of instructional hours, and lastly the upgrading mathematics courses were analyzed.

Chapter 5

Summary, Results, Conclusions and Recommendations

The final chapter of the study presents a summary of the problem, procedure, and findings. Comments, conclusions and the implications which have become apparent as the result of the analysis are treated in the subsequent sections. Recommendations for further study complete the chapter.

Summary

The objectives of this study were: to describe the various mathematics courses in the engineering technologies of the Western Canadian institutes of technology; furthermore, to determine the kind of mathematics courses offered to these technologies; and to consider the differences, if any, in the course content. The total number of instructional hours in mathematics, the mathematics entrance requirements, and the availability of upgrading programs were also considered.

These objectives were met by collecting, compiling, summarizing and interpreting the data obtained from the calendars of the six Western Canadian Institutes of Technology. Data regarding the engineering technologies, admission requirements in mathematics, upgrading programs for prospective students, and credit was obtained by a questionnaire from the heads of the mathematics departments. The various mathematics courses were tabulated by institutes; these courses were described in a tabulated form using topic

headings as the basic components. The calendar headings which were unchanged and used in this study, and the topic headings indicated the kind of courses offered to the technologies. The tabulated data was used to analyze the differences in mathematics course content of the related technologies. The tabulated data regarding the total number of instructional hours in mathematics was presented and the mathematics admission requirements were stated. The last objective was met by summarizing the information regarding upgrading programs in mathematics.

Results

In answer to the problem statement, the description of the range and level of the mathematics courses is presented in one form in Table 2 to Table 6, and in another form in Table 9 to Table 24.

The mathematics courses are technical in nature, as is made explicit by the topics listed in the calendars. There was only one reference made to sets which imply abstract algebra. That occurred in the SAIT calendar in the case of ALG-002, Table 23. The range of courses extend from algebra, through trigonometry, introductory calculus, advanced calculus, statistics, introductory computer programming to advanced computer programming and applications in general.

The level of the courses varies from technology to technology and is enriched by specialty courses as required by the technology.

The mathematics courses are technical and applied instead of abstract as shown by the majority of the course descriptions.

The level and range of the content of the mathematics courses show limited homogeneity within the related technology groups. In most cases there is a consistency regarding basic trigonometry, basic algebra and introductory calculus. Exceptions are just as common, however. For example, in the case of Group 1, Air Conditioning, and Group 2, Architectural, there are differences in not only the type of courses but also in the mathematical topics covered in the same course. Differences occur in the more advanced topics of calculus and in course offerings such as statistics, and computer programming. At two of the three institutes, STI and SAIT, introductory calculus is being offered to Architectural Technology while at the other institute, NAIT, only basic technical mathematics and computer programming are offered to this technology.

There are major differences=between the institutes in the degree of specificity of mathematics courses offered to the technologies. Some institutes for example, to some extent, BCIT offer a limited number of courses which apply to the majority of the technologies. Some of the institutes offer specially designed courses to the technologies in order to satisfy their needs; for example this is done to some extent at NAIT. The data shows that the institutes, including BCIT and NAIT, have taken a position between

these two extremes, offering some core courses common to the majority of the technologies, and offering some "tailor-made" courses in order to satisfy the specific requirements of the particular technologies.

There was no predictive characteristic found in the distribution, or in the weighting, of the total number of instructional hours in mathematics.

There was limited uniformity found in upgrading courses. In some cases, for example at NAIT, a program is organized and students can register for it. In other cases, for example BCIT, there is no provision made for upgrading. In Manitoba, Saskatchewan and in Alberta, programs have been established to assist the prospective students in meeting the necessary admission requirements through upgrading. Alberta provides the greatest degree of assistance through development of pre-technology programs for mature or young students; Manitoba is second in this regard. There are some signs of development in the upgrading programs for mature students at the two institutes of Saskatchewan.

There is complete agreement between RRCC, STI, SIAAS and BCIT in admission requirements. At NAIT and SAIT the admission requirements vary from Grade XII mathematics to Grade XI mathematics.

In most cases, the institutes using the semester system have a greater total number of mathematics instructional hours than the institutes operating on the quarter system.

Conclusions

There is a large area of study in technical mathematics common to the six technical institutes: algebra, trigonometry, calculus, computer programming and statistics.

Considering related technologies at the different institutes, in most cases the mathematics course offerings differ in the mathematical subject titles, in content, and in the number of hours of instruction. There was only one group found, Group 3 Chemical, in which the courses were almost identical.

On the basis of the differences in mathematical subjects and course content it is concluded that there is no, or very limited, overall co-ordination of mathematics offerings and of content for these institutes.

The agreement in course contents regarding a particular technology is coincidental rather than the effect of a co-ordinating body.

It is not possible to state a general rule regarding student transfer from one institute to another. Decision has to be made on the individual basis considering the particular technology.

The calendars' course descriptions, in some cases, are too general to be used for course evaluation. However, the calendars give sufficient information for determining credit.

Recommendations for Further Study

To the researcher's knowledge this has been the

first descriptive study of the range and level of the mathematics courses of the institutes of technology. This study has been limited to six institutes and to the four Western Provinces of Canada.

1. A similar study should be attempted for the other provinces of Canada for the purpose of comparison.

2. A comparative study between the Canadian institutes of technology and some of the two year colleges in the United States regarding mathematics subject offerings, creditation of graduates, and co-ordination of curriculum development would be in order.

3. A study covering Canada, parts of the United States and some European countries regarding mathematics curricula in order to discover the differences could be justified. This study should be extended to include information on the co-ordinating bodies affecting mathematics curricula.

Researcher's Observations

In conducting this study the following observations were made without support of the data or findings:

1. In some cases in the literature there were references to professional associations setting standards for graduates of the institutes of technology and other technicians training institutions. These references all pertained to the United States. There was no similar information found regarding Canada.

2. The noted differences in mathematics course offerings may indicate an attempt by the institutes to satisfy local requirements stated by the advisory committees. In general, the standard in basic mathematics courses, such as algebra, trigonometry, and introductory calculus seems to be uniform, although with some exceptions. The establishment of some overall co-ordinating body would be justified, however. Such a body could have some influence on the minimum number of hours of instruction in mathematics, and set some overall standards for mathematics courses offered to the technologies.

3. The establishment of an overall co-ordinating body would be justified by the fact that at most institutes the mathematics is taught by a separate mathematics department as a service course. The number of hours of instruction and the content are usually determined by the particular technology in consultation with the mathematics department. This fact places the mathematics department in a weak position. An overall standard perhaps could strengthen the positions of the mathematics departments. Thus the students would leave the institutes with a better mathematics background facilitating retrainability for them.

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APPENDIX

Correspondence

This appendix includes copies of correspondence referred to in the study.

March 30, 1972

Head, Mathematics Department

Dear Sir:

I am planning to make a brief study of the mathematics courses offered to the engineering technologies at the six western Canadian institutes of technology. This plan was prompted by my inadequate knowledge regarding the mathematics offerings of the institutes, their mathematics admission requirements, the existence or non-existence of upgrading programs in mathematics, and last but not least, the problem of determining credits in cases of student transfers.

May I request your co-operation? Enclosed is a questionnaire which I would appreciate your completing and mailing to me in the envelope provided. In return, I will send you the tabulated data which should be ready shortly. If your 1972-73 Calendar is available, please send me a copy.

I would appreciate your returning the completed questionnaire at your earliest convenience.

Thank you for your co-operation.

Yours sincerely,

L.M. Morgan
Section Head
Mathematics
Academic Studies

Encls.

QUESTIONNAIRE

1. List those technologies in your institution which you would classify as engineering technologies.

2. List the mathematics admission requirements for the engineering technologies. (If you are sending a 1972-73 calendar and the admission requirements in it are up-to-date, do not answer this question.)

3. Describe the kind of mathematics upgrading programs offered to prospective students in order to satisfy admission requirements of the engineering technologies.

4. In case of student transfers do you decide giving credit on the basis of

   a) comparing the mathematics course content description of the calendar of the particular institute to your own courses?

   b) an examination given by your department?

   c) other methods (please specify)?